TIDAL HARBOURS COMMISSION.

FIRST REPORT

OF

THE COMMISSIONERS.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET,
FOR HER MAJESTY'S STATIONERY OFFICE.
1845.

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COMMISSION.

VICTORIA, BY THE GRACE OF GOD, of the United Kingdom of *Great Britain* and *Ireland* Queen, Defender of the Faith. TO Our trusty and well-beloved *William Bowles*, Esquire, Companion of Our Most Honourable Military Order of the Bath, Rear Admiral of the Blue Squadron of Our Fleet Sir *James John Gordon Bremer*, Knight, Commander of Our Most Honourable Military Order of the Bath, Captain in our Navy, *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, and *Thomas Baring*, Esquires, Our trusty and well-beloved *Francis Beaufort*, Esquire, Captain in Our Navy, Hydrographer of Our Admiralty, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, Esquire, Our Astronomer, or Our Astronomer for the time being, Our trusty and well-beloved *John Washington*, Esquire, Captain in Our Navy, and *Richard Godson*, Esquire, Counsel for the Affairs of Our Admiralty and Navy for the time being, greeting: WHEREAS We did by our Letters Patent under the Great Seal of Our United Kingdom of Great Britain and Ireland, bearing date at Westminster the First day of February, in the Eighth year of Our Reign, nominate, constitute, and appoint you the said *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, *Thomas Baring*, *Francis Beaufort*, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, or Our Astronomer for the time being, and *John Washington*, together with our right trusty and well-beloved Councillor *Henry Thomas Lowry Corry*, and Our trusty and well-beloved *Henry John Shepherd*, Esquire, to be Our Commissioners for inquiring into the state and condition of the Harbours, Shores, and Navigable Rivers of Our United Kingdom of Great Britain and Ireland, and as to the powers of the Commissioners deputed and assigned for Executing the Office of Our High Admiral of Our said United Kingdom of Great Britain and Ireland for the conservation of the same; And also what measures might be necessary for removing and preventing impediments to Navigation: NOW KNOW YE that We have revoked and determined, and by these presents do revoke and determine, the said recited Letters Patent, and every clause, article, and thing therein contained: AND FURTHER KNOW YE that We, confiding very much in your fidelity, discretion, diligence, and careful circumspection, of Our especial Grace, certain knowledge, and mere motion, have nominated, constituted, and appointed, and by these Presents do nominate, constitute, and appoint you the said *William Bowles*, Sir *James John Gordon Bremer*, *Joseph Hume*, *Aaron Chapman*, *Edward Royd Rice*, *Thomas Baring*, *Francis Beaufort*, or the Hydrographer of Our Admiralty for the time being, *George Biddel Airy*, or Our Astronomer for the time being, *John Washington*, and *Richard Godson*, or Our Counsel for the Affairs of Our Admiralty and Navy for the time being Our Commissioners for the purposes herein after mentioned.

AND We do by these Presents give and grant unto you, or any five or more of you, full power and authority to inquire into the state and condition of the Tidal and other Harbours, Shores, and navigable Rivers, of Our United Kingdom of Great Britain and Ireland; and to ascertain what changes have taken place in any of such Harbours, Shores, and Rivers, as respects Bars, Entrance, Depth of Water, extent and amount of Scour, or otherwise, and what encroachments have been made upon them, or upon the Waters above such Harbours and Rivers, by Enclosures of Lands, Embankments, Wharfs, Piers, or other works, and by whom and by what authority such Encroachments have been made, what effect they have or may hereafter produce, and also what injury may have been done, or may accrue, by the removal of Shingle, Rock, Soil, or other materials, from any Shores, or by the emptying Ballast or other materials into or near any such Harbours and Rivers, or in consequence of Wreck not being removed, and what measures are necessary and expedient to remedy and prevent any injury that may have resulted, or may be likely to result, therefrom; and also whether there are sufficient powers for enforcing such remedy, and whether any and what further powers are necessary.

AND We do further by these presents give and grant unto you Our said Commissioners, or any five or more of you, full power and authority to inquire into the present state of the Law as regards the powers of the Commissioners deputed and assigned for executing the Office of Our High Admiral of Our United Kingdom, for the conservation of all Harbours, Shores, and Rivers of Our said Kingdom; and how far the powers given to any Bodies Corporate, Commissioners, Trustees, Local Authorities, or other persons, by any Charters or other Acts of Us or of Our Predecessors, Kings and Queens of England, Scotland, and Ireland, or by any public, local, or private Acts of Parliament, supersede or interfere with the powers and authority of the Commissioners assigned and deputed to execute the Office of Our High Admiral of Our United Kingdom; and whether any, and, if any, what legislative measures or other acts are necessary to confer upon the same Commissioners sufficient powers to remove or prevent encroachments, or the constructions of any work, or for the removal of wreck, or for preventing any act which has or has a tendency to have an injurious effect on any Harbour, Shore, or navigable River of Our said United Kingdom.

AND We do further by these Presents give and grant unto you Our said Commissioners, or any five or more of you, full power and authority to inquire and ascertain what measures you may deem expedient for the improvement of the Harbours and Rivers of Our same Kingdom.

AND We do further by these Presents authorize and empower you, or any one or more of you, to visit and personally inspect all the Harbours, Shores, and navigable Rivers of Our United Kingdom, or such of them as you may deem expedient, and to employ Engineers and other persons to make surveys of such Harbours, Shores, and navigable Rivers, who are to report thereon to you.

AND We do by these Presents give and grant to you, or any one or more of you, full power and authority to call before you, or any one or more of you, at any place you, or any one or more of you, may think necessary, such persons as you, or any one or more of you, shall judge requisite by whom you may be better informed of the truth in the premises, or from whom you, or any one or more of you may consider it desirable to obtain information for the purposes of this Commission, and to inquire into the same, and every part thereof by all other lawful ways and means whatsoever.

AND We do further by these Presents give and grant to you, or any one or more of you, full power and authority, where the same shall appear to you, or any one or more of you, to be requisite, to administer an oath or oaths to any person or persons whomsoever to be examined before you, or any one or more of you, touching or concerning the premises.

AND Our further Will and Pleasure is that you, or any five or more of you, upon due examination of the premises, do and shall report to Us in writing, under your hands and seals, your observations as to what you shall find touching or concerning the premises upon the said Inquiry; and also your opinions as to the amendment, if any, of any of the existing Laws having reference to the objects of this Commission.

AND We further will and command, and by these Presents ordain, that this Our Commission shall continue in full force and virtue, and that you Our Commissioners shall and may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

AND We do hereby direct and appoint that you, or any five or more of you, may have liberty, should you deem it expedient, to Report to Us your several Proceedings under this Commission from time to time, as the same shall be respectively completed and perfected.

IN WITNESS whereof We have caused these our Letters to be made Patent. WITNESS Ourself at Westminster the Fifth day of April, in the eighth year of our reign.

By Writ of Privy Seal.

EDMUNDS.

REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

We, the undersigned Commissioners, appointed by Your Majesty to inquire into the state and condition of the Tidal and other Harbours, Shores, and navigable Rivers of Great Britain and Ireland, humbly beg leave to report our proceedings in the execution of Your Majesty's Commission.

The various points of inquiry to which our attention is directed in the instructions given to us for our guidance may be conveniently classed under four heads, viz.:—

First.—As to what changes have taken place in any of those tidal harbours or navigable rivers.

What encroachments have been made upon them; by whom and by what authority so made; and the effect that such encroachments have produced or may hereafter produce.

What injury may have been done to those harbours and rivers, or may accrue to them by neglect, or by the unauthorized removal of shingle or other materials from their shores, or by the improper discharge of ballast, or by the drainage of mines, or by the diversion of their tides or streams.

Secondly.—What measures are necessary as well to abate any of the said injuries as to prevent any future mischief.

Whether there are sufficient legal powers for enforcing such remedy, and if not what further powers are necessary.

Thirdly.—To inquire into the state of the law as regards the powers of the Lords Commissioners of the Admiralty for the conservation of all the harbours, shores, and rivers of the United Kingdom.

How far the powers conceded to particular authorities or persons, by Charter or by Royal Grant, or by Act of Parliament, may be held to supersede or to interfere with the jurisdiction of the Admiralty.

Whether any, and what, Legislative measures are necessary to give the Lords Commissioners of the Admiralty sufficient powers to remove any present or future encroachments, and to prevent the construction of any works which may have an injurious effect on any harbour, shore, or navigable river.

Lastly.—To inquire what measures it may be expedient to adopt for the general improvement of the harbours and rivers of the United Kingdom.

We entered on these several points of inquiry with a full sense of their deep importance, not only as involving the general benefit of the public and the protection of our commerce, but also the welfare of a large class of Your Majesty's most valuable subjects, the merchant seamen of this great maritime empire; and it is our earnest hope that we may be enabled to point out simple and efficacious means whereby our tidal harbours may be rendered more available to the prosperity of our commerce and more accessible in the hour of need.

The labours of the Commission have been anticipated, in some measure, by the Orders of the House of Commons of the 22nd July and 9th August last; in compliance with which Returns have been received from 260 harbours and havens governed by Act of Parliament, Charters, &c., comprising a mass of valuable information respecting the tidal harbours and navigable rivers of the kingdom, which will require much time to examine carefully, and to form a digest of them. But having in an early stage of our Inquiry become deeply impressed with the necessity of some Legislative measure to be taken with as little delay as possible to remedy the injuries which have already taken place (and are daily increasing) to the navigation of many of the tidal harbours throughout the United Kingdom, we determined to confine our inquiries in the first instance to a few specific cases bearing directly on that general question. See App. p. 143.

We have therefore selected, as examples, the rivers Clyde and Tay, and the harbour of Montrose, in Scotland; together with Southwold, Harwich, and Rye, in England; and we find that very great and increasing injury to the best interests of the country has accrued from negligence of the several authorities in permitting the improper removal of soil and beach, as well as by embankments, weirs, and other obstructions of a similar nature which check the free flow of the tide, impair its strength, and thus permanently diminish the general depth of the river. And, on the other hand, that when the aid of experience and science has been called in, and a due vigilance has been exercised, a proportionate improvement has invariably been the result.

THE RIVER CLYDE AND HARBOUR OF GLASGOW.

See Plan in App.

The river Clyde offers an instructive example of what enterprise and persevering efforts will accomplish, but at the same time a proof that even such efforts require to be controlled by some competent and disinterested authority.

This noble river, traversing a large part of the western lowlands—the third Scottish stream in point of magnitude, but the first in commercial importance—drains an area of 1200 square miles, or a twenty-fifth part of the whole of Scotland.

Smeaton, 1755.
Golborne, 1768.
Watt, 1769.
Smeaton's Rep. p.1.

From the reports of the Engineers Smeaton, Golborne, and Watt it appears that, about 90 years since, the navigation of this river, as well as the flow of the tide, was so much obstructed by sand-banks, that barges drawing 3 feet water could alone be employed in the trade of the important city of Glasgow; that its manufactures were necessarily carried down to Port Glasgow or Greenock in order to be shipped for exportation; and its imports, in the same manner, were transhipped into barges to be brought to the city. At this time the rise of spring tides at Hirst Sand, a little below Glasgow, was only 1 foot 9 inches, and the total depth at high-water spring tides was but 3 feet 3 inches. So hopeless did the case seem, that in 1755 Smeaton proposed a lock across the river at Marling Ford, about four miles below the city, so as to form the upper part of the river into a canal; and for this an Act of Parliament was actually obtained. Happily, however, for the commercial interests of Glasgow, Golborne, in 1768, took a different view of the capabilities of the river, and recommended the contraction of the channel and the free use of the dredge. These means having been adopted, and perseveringly employed by subsequent engineers, the result is that at this moment there is a depth of 17 feet at high-water at Glasgow Quay, and that large ships now embark and unload their cargoes where formerly a laden barge could barely swim.

Golborne's Rep. p. 2.
Question 29.

	Vessels.	Tons.
In 1844 the number of arrivals was . . .	13,919 of	1,101,949

Parl. Papers, No. 349, for 1845; and App. p. 163.

And there are now 60 steam-vessels belonging to the port; as well as 940 arrivals and sailings annually of traders, not one of which, at the former period, could have approached nearer than Dumbuck Ford, 12 miles below the city.

These are great improvements, and highly honourable to the spirit and enterprise of this city, yet it must be remembered that such results have been obtained at a vast sacrifice of money levied by heavy dues upon shipping, which nothing but great commercial prosperity could have borne.

Evidence on Clyde Navigation Bill.

	£
In 1770 the gross harbour dues for the year were . .	147
In 1841 ,, ,, . .	50,292
And the total receipts since the year 1770 exceed . .	800,000

49 Geo. III. cap. 74.

But engineering skill being not only slow in its development, but having often to struggle with prejudice and self-interest, it has now been discovered that many of the plans of the Clyde Trustees were short-sighted; that in order to continue their improvements in deepening their river, they must now submit to a large outlay for rebuilding bridges, the foundations of which were not laid deep enough; that weirs have been permitted across the river, nay, sanctioned by Act of Parliament, so as to prevent the flow of the tide above the city, and stop all navigation above the bridges; that a considerable expense for dredging might have been saved if the natural flow of the tidal water had been properly directed; the harbour space might have been enlarged, and the general depth of water throughout the river increased; and that, with all these improvements, the dues on shipping might have been lightened, and the ports of Greenock and Port Glasgow, at the mouth of the Clyde, might have been spared a large expenditure in the construction of docks, made in expectation of traffic which it is not probable will ever now be realized.

THE RIVER TAY.

The river Tay is the largest of all the Scottish streams; its extreme length being about 180 miles, draining an area of 2300 square miles, and pouring more water into the ocean than any other river of Great Britain. See Plan. in App. In point of commercial consequence, it is inferior to the Clyde; but the rapid strides made by Dundee within the last 10 years, and the increase in the shipping at Newburgh and Perth, make the preservation of this river a subject of great importance, and render it the more necessary to show how much it had suffered while it was abandoned, and how satisfactory have been the results since improvements began. Q. 403—409.

Down to the year 1834 the upper portion of the Tay, as far as navigation was concerned, seems to have been entirely neglected. Q. 290—294. Landed property on each side of the stream, and the right of salmon fishing, seem to have been paramount to every other interest: jetties or dikes, in order to form new ground, were run out at pleasure; and large heaps of stone, called fishing cairns, were erected at will in the bed of the stream; while, below, only a single fairway buoy was placed to mark the entrance between two dangerous sands at the mouth of the river. The Perth Commissioners at length became alive to the mischief of neglect; a strong report from their engineer on the shameful state of the river and on its capabilities roused them to activity, and in 1834 a Bill was obtained Q. 342—344. to empower them to raise money for its improvement. During the next five years the process of deepening the bed and straightening the channel of the river was steadily continued, and by thus affording a free passage to the tidal waters a depth of 15 feet at high-water of spring tides has been obtained near Q. 355—360. the city, and the flood tide now begins to flow three-quarters of an hour earlier than formerly at Perth bridge.

The value of such unrestrained action to the tidal waters seems not to be confined alone to the upper channel of the river, for according to the report of the Admiralty surveyor, (printed in the Appendix,) it has caused an increase of App. p. 154. depth at the Tay Bar, and dispersed a large quantity of the sand which had there accumulated. The signal success of these efforts in the Tay as well as the Clyde, holds out great encouragement to persevere in deepening the channels in all our tidal rivers.

Nor have the trustees of Dundee Harbour shown less energy in keeping pace with the extension of manufactures in their town; by the establishment of suitable docks and basins they have raised it to be a first-class commercial port; and by their judicious enterprise during the last 30 years they have more than quadrupled the number of its shipping as well as the amount of its revenue.

	£.	
In June, 1815, the total revenue of the port was . .	4,096	Printed Abstracts of Income and Expenditure.
In June, 1844, „ . .	23,895;	

while the number of vessels had increased to 3791, having a burthen of 272,239 tons.

The Tay is however susceptible of much further improvement: there are Admiralty Survey. still many obstructions in the bed of the river to be removed; dangerous rocks Rep. App. p. 155. near the entrance of the inner harbour at Dundee are yet to be blasted; and a recent attempt, to grasp an area of about 2000 acres below high-water mark, Q. 425—430. near Powgavie, on the north shore, has to be frustrated. In short, here as elsewhere, the watchful eye of a permanent conservative guardianship is absolutely required in order to preserve this fine river for its daily increasing trade.

MONTROSE

At Montrose we find a similar instance of encroachment on the banks of the South Esk (the details of which appear in the evidence), where the proprietor Q. 1574—1657. of the adjoining land even questions the authority of the Admiralty to oblige him to restore to the harbour a part of the tidal water of which it appears it has been deprived by his embankments. The Montrose Trustees having, with Q. 1670. much public spirit, recently expended the large sum of 42,000*l.* in constructing a wet dock and in improving their harbour, have not the means of contesting with a wealthy proprietor, the point at issue, and therefore naturally look to the Admiralty for protection. But as this case is now in course of legal process by the Lord Advocate of Scotland, we abstain from further comment.

ARBROATH.

Q. 1058—75. Arbroath, a port on the east coast of Scotland, about halfway between Montrose and the river Tay, and the seat of extensive manufactures, falls under a different head of inquiry from the harbours we have hitherto examined into, but is not the less, we conceive, within the limit of our instructions.

The evidence laid before the Commission evinces an extent of public spirit on the part of the inhabitants and trustees of this burgh in the highest degree Q. 1045. deserving encouragement. Seven years ago the harbour was the property of the Corporation, and its revenues were applied in lighting, paving, and cleansing the streets. The harbour was insufficient for the shipping belonging to the place, and unfit for the reception of vessels of any considerable size. But in the year 1838 the inhabitants voluntarily came forward and taxed themselves in order to pay those municipal expenses; and an Act of Parliament, in 1839, Q. 975—6. having empowered the trustees to raise money, a sum of not less than 58,000*l.* has been since that time expended in works for enlarging and improving the port, whereby the accommodation for shipping is more than doubled.

Arbroath Memorial in App. p. 161.

			£
In 1746 the shore dues amounted to		. . . .	21
In 1823	„	„	616
In 1843	„	„	3050

showing, since the internal improvements of the port, a rapid increase in the amount of traffic.

But the estimated expense of executing those works, as in nearly all similar cases, has proved too small. As far as they have been carried out they are constructed with deep foundations, and are of a substantial and stable character. Q. 1008. But the deepening of the harbour, with its entrance and approaches, is still unfinished; and having exhausted all their resources, the trustees have memorialized Your Majesty's Government for a small grant, to enable them to complete the projected works; without which, what has been done will be in a great measure unavailable.

The works proposed, it appears in evidence, would give a mean depth of Q. 1021. 16 feet at high-water of ordinary spring-tides,—they would render Arbroath a tidal harbour of refuge, for 12 hours out of the 24, for all vessels of the size which usually frequent that coast; and they would thus be as great a benefit to the public as to their enterprising owners; for the greater part of that rocky coast, when it becomes a lee-shore, is extremely dangerous, as was too fatally Q. 1027. proved in the gale of January, 1800, when 40 vessels were wrecked, and 13 of them within a few miles of Arbroath.

Taking all the above-mentioned circumstances into consideration, it appears to the Commission that this case comes so distinctly under the fourth head of inquiry pointed out to us by our instructions, that if in any instance Your Majesty's Government should be disposed to aid the local exertions of the trustees of a harbour, this case seems deserving of encouragement, and we therefore humbly beg leave to recommend to Your Majesty the prayer of the Trustees of the Harbour of Arbroath.

THE RIVER BLYTH AND HARBOUR OF SOUTHWOLD.

In the northern portion of Your Majesty's dominions we have seen that although great want of vigilant control is manifest, and that the landed, and fishing, and corporation interests have too often been preferred to the rights of merchants and ship-owners, and to the general interests of navigation, still the spirit of commercial enterprise has finally broken through the barrier, and by degrees has carried out, to a certain extent, improvements in some of the harbours. In the southern ports, which we have now to notice, we regret to report that those interests have proved too powerful, and that the consequence has been in several cases a dry bar, a deserted port, and all but ruin to the ship-owner and merchant.

The river Blyth and the port of Southwold on the east coast of Suffolk offer a strong proof of the correctness of these statements.

See Plan.

It appears in evidence that the whole area formerly covered by the spring-tide waters of the river Blyth was about 2,000 acres, and that by means of the several embankments shown in the accompanying plan, that area has been reduced to 450 acres, or less than a quarter of the whole extent. It likewise appears that over more than half the original area the depth at high water ordinary springs would be two feet; that in the event of high springs it would be four feet, and in north-west gales or equinoctial springs, fully six feet. We have thus the means of computing roughly the quantity of water which has been excluded by these embankments; and taking the lowest estimate, or that of a common spring tide, it gives, in round numbers, 150 millions of cubic feet, or 4½ millions of tons on every tide; and as three such tides occur at each new and full moon, or seventy-eight in a year, some notion may be formed of the enormous loss of scouring power sustained in consequence of these embankments.

Engineer's Rep. in App. p. 171.

Admiralty Survey. Rep. App. p. 173.

Engineer's Rep. in App. p. 172.

The merchants of Halesworth (the great corn mart of this part of the county of Suffolk) had repeatedly urged the propriety of deepening the bed of the Blyth; yet nothing was done till an Act of Parliament was obtained in 1830, and though under direction of the present harbour Surveyor, the lower part of the harbour has been somewhat improved; yet as the Act did not touch the embankments, the bar has been at times since that period dry at high water, so that no vessel could get in or out.

Q. 1114.

Q. 1143.

As a general, although not universal principle, no cause has operated more extensively to injure the entrances of harbours throughout the United Kingdom than excluding the tidal waters from lands below the level of high-water, which served as natural reservoirs for the flood tide, and were the means of affording a valuable scouring power during the ebb. Nor does any subject more deserve the vigilant attention of Your Majesty's Government, or of those entrusted with the conservancy of our harbours, than such encroachments, which are usually made quietly and gradually, and when once completed are difficult afterwards to remove.

It appears in evidence that, with the exception of two, the Southwold Harbour Trustees are self-elected; they consist of landed proprietors, merchants, &c., but only a single sailor.

Q. 1121—33.

We have thought it right to enter into the above details, since Southwold is entirely dependent upon tidal waters for existence as a port, and since the value of the daily tidal scour in all our harbours does not seem to be sufficiently appreciated; nor can any case more strongly prove the duty of jealously guarding against similar encroachments.

HARWICH HARBOUR.

The ancient and well-known port of Harwich is an estuary formed by the junction of the rivers Stour and Orwell, and contains about 700 acres of good anchorage. The value of this port was well understood during the last war, and will be so again when we have occasion for another North Sea fleet. It was from Harwich that the fleet was watered by transports; and that all its vessels obtained supplies at the naval yard; here not less than 60 ships of war have been built, 15 of which were two-deckers; and the fishing vessels belonging to the port some years since were estimated at 3000 tons, and employed 500 of our most hardy seamen.

See Plan in App.

Admiralty Survey. Rep. App. p. 176.

Its general depth of water, its wide extent, its perfect shelter, its easy access by night or by day, in all weathers, and in all states of the tide, render Harwich the only harbour of refuge, properly so called, between the Thames and the Humber.

Yet it will be seen from the plan annexed to this Report, and from the evidence taken before the Harbour of Refuge Commission of 1844, that this harbour, which in easterly gales has given shelter to 500 sail of shipping at once, has been suffering a rapid deterioration during the last 30 years from the removal of the cement stone at the foot of Beacon Cliff and Felixstow Ledge. The consequence is, while the sea has gained considerably upon the Essex shore, threatening to break through the isthmus, that Landguard Point, on the opposite side, has advanced 500 yards upon the sea during the same period,

Q. 1220—24.

App. p. 176.

Admiralty Survey. Rep. App. p. 176. thereby blocking up the chief entrance into the harbour; and so much so, that where, in the year 1804, there was a channel seven fathoms deep at low water, there is now a shingle-beach as many feet above high-water mark.

But the attention of Your Majesty's Government having at length been called to this state of neglect by the Report of that Commission, it appears that immediate measures are to be taken to restore this port to its former value as a Harbour of Refuge.

RYE HARBOUR.

See Plan in App. Rye, one of the Cinque Ports, on the coast of Sussex, lies in the bight of a bay, about three miles deep, bounded by Dungeness to the east, and Fairlight Head to the west. The present harbour is in the lower part of the channel of the river Rother, and just below the junction of the Tillingham and the Brede, two small streams flowing from the north-west. A rubble-stone pier, which does not reach within 1200 yards of low-water mark, is in the course of construction on the eastern side of the harbour, and an embankment of earth has been thrown up on the western side, leaving an entrance between of 290 feet in width.

Q. 2186. The average rise of spring-tides at the town of Rye is 14 feet, at the pier-head 17 feet, and in the bay 23 feet, or greater than anywhere on the south-eastern coast of England. At low-water the harbour is left dry.

For several miles round the town of Rye, and immediately adjacent to the harbour, there are large tracts of marsh land, the greater part of which are owned by proprietors residing in the neighbourhood. Over a great portion of this plain the sea was formerly accustomed to flow at every tide, and thus formed a considerable back water, which operated as a scour to the harbour of Rye, and kept the channel open. The proprietors, however, uncontrolled by any guardian of the port, began by degrees to exclude the tide, and no steps being taken to restrain their encroachments, they obtained an Act of Parliament, erected dams and sluices across the rivers a short distance above the town, and finally excluded the tidal waters.

By these means hundreds of acres of marsh have been reclaimed, while the harbour, deprived of its back waters, yielded to the mass of sand and shingle which rolled in with every wave, and which have now nearly obliterated the appearance of a channel.

Rennie's Rep. in App. p. 193. Three rivers drain this tract of country; and had there been no obstructions in their channels, they would have afforded an ample reservoir for tidal waters; and indeed would still do so, judging by the effect produced when, in March, 1812, owing to a high tide blowing up Scot's Float Sluice, the sea flowed freely to Robertsbridge, 15 miles up the country, and the returning ebb, as it appears in evidence, so scoured the harbour that vessels drawing 16 feet
Q. 2044. water could get up to the town.

Landed interest, however, again prevailed, and in the following year the sluice was re-built. In 1830, a jury at Croydon found "that Scot's Float Sluice, as then erected, was a nuisance," and alterations in it were directed to be made;
Q. 2227. these alterations not being made, it appears that the people assembled and pulled the sluice down.

An inquiry took place which led to the Acts of 1830 and 1833; under which one of the Rye Commissioners was named on the part of the Admiralty,
Q. 2200—12. and we learn from his evidence, that since his appointment, an extensive creek, called the Nook, to the westward of the entrance, and covered every high water, has been in great part dammed out; and upwards of 700 acres of marsh land, lying on both sides the river, and overflowed by the sea to the depth of
Q. 2243. 3 feet, has been embanked, thereby losing the scour over the bar of 30 million cubic feet of water on every spring tide.

It appears, from the reports of engineers and others, that between the years 1724 and 1787, a sum of not less than 200,000*l*., raised by a passing toll on shipping, was expended in vain attempts to form a new harbour about two miles to the westward of the present outlet to the sea, but which, after those 63 years' waste of time and money, they were compelled to abandon.

We have dwelt longer on this subject than at first sight it would seem to warrant, but the case of Rye is extremely instructive, as bringing broadly into view the apparently antagonist principles of the local and the shipping interests, and the absolute necessity of some controlling power to protect, the latter. There is a still more important consideration. Rye is situated on a part of the coast of Your Majesty's dominions, where a harbour is most wanted; and where it would be of the greatest benefit to our shipping, whether for steamers to obtain fuel in the event of hostilities, or, which is of far more consequence, for the safety of our merchant vessels in time of peace. And when we consider the capabilities it offers, the abundance of level land on either side of the river fit for docks or basins; the great value of a 23 feet rise of tide in the bay; and the extent of back water at command, we are led to believe that skilful engineering would readily turn these advantages to account for national benefit.

THE RIVERS FORTH, DEE, &c.

In addition to the examples we have given in detail, numerous instances of encroachments, of neglect, and of want of efficient control, have come before us in the course of our inquiries. For instance, on the banks of the Forth, near Stirling, large enclosures of marsh land have been formerly effected. Similar embankments, but to a much greater extent, have been carried out on the level lands by the side of the Dee, near Chester. At Whitby, we learn that it is a common practice to throw the refuse of the town behind the west pier head, which the next flood tide washes into the harbour. At Bridlington, great delay has occurred in completing the works for the improvement of the harbour, while a passing toll to pay for them is levied on all shipping. So unimportant, too, is this harbour considered, that a railway company recently inserted it in its schedule of property to be taken, amidst houses, fields, &c., without deeming the transfer of a public harbour of sufficient consequence to give it a clause in their Bill.

Q. 1805.

Engineer's Rep. App. p. 182.

Admiralty Survey. Rep. App. p. 179.

At the Spurn Point six vessels, of 50 tons each (paying 1*l.* a load to the Lord of the Manor), are daily engaged in carrying off the shingle from the beach, at the rate of 50,000 tons a-year, to mend the roads in Yorkshire and Lincolnshire. As it appears from the Report printed in the Appendix that the Spurn Point has lost half its breadth within the last 20 years, this removal of shingle may eventually endanger the lighthouses as well as the anchorage of Hawke Roads.

Admiralty Survey. Rep. App. p. 164.

At Portland, ballast is commonly thrown overboard with impunity. Similar complaints come from Fowey and from Falmouth; and with the addition from Milford Haven, that the water-bailiff remonstrates in vain, and has practically no power to enforce his commands.

We have the evidence of engineers, and of the Admiralty surveyor, that the Rivers Lune and Ribble, and Dee, are all susceptible of very great improvement; the Thames, even, the high road of the commerce of this great empire, for want of systematic conservancy and efficient dredging, has shoals with only 11 feet depth over them, even as low as Barking Reach, which prevent more than half the loaded vessels that come up to London from passing at low water spring tides; in short, there is hardly a harbour we have inquired into that, under efficient control, might not be in a much improved state.

Q. 1745—55.

We now proceed to the third head of our instructions, namely, to inquire into the state of the law as regards the subject under consideration, and we shall, on the present occasion, confine ourselves to a brief statement thereof.

The power, interest, and jurisdiction of Your Majesty extend in right of Your Majesty's Crown over all the seas and the shores thereof surrounding Your Majesty's dominions of Great Britain and Ireland; and in the same right Your Majesty has the property of the soil in all rivers which have the flux and reflux of the sea up to high-water mark of ordinary spring tides.

Magna Charta, c. 16 and c. 23, 25 Edw. III., c. 4.

Lord Hale, De Jure Maris, p. 17, and De Portubus Maris, p. 81.

Your Majesty's ancestors have from time immemorial exercised those powers, enjoyed the property and profits, and enforced that jurisdiction.

Chitty on Prerog. of Crown, p. 173.

The Lord High Admiral has, by prescription recognized by statute, the conservancy of the harbours and navigable rivers of Your Majesty's kingdom, and may inquire if any be guilty of any nuisance to such harbours and rivers.

Callis on Sewers.

If any nuisances were erected in any harbour or navigable river the Lord High Admiral formerly caused the Attorney-General to file *ex officio* informations against the parties. They might also be pursued by indictment. But either remedy was dilatory and expensive. Parliament attempted to find expeditious methods for preventing nuisances, and for removing any that might be erected, and passed the Act of 46 Geo. III., chap. 153, but it has been found wholly ineffectual to accomplish those objects.

Your Majesty's ancestors have by grants and charters given to certain bodies politic and corporate, the conservancies of certain harbours and rivers, and we find that the soil of the river Thames is claimed by the Corporation of the City of London, and that the soils of many navigable rivers are claimed by the owners of the lands on the banks thereof. Although a subject may by grant have the property of a navigable river, yet Your Majesty hath a right of empire or government over it in reference to the safety of the kingdom, and the people have a public interest of passage and repassage with their goods, and must not be obstructed by nuisances or impeached by exactions, for the *jus privatum* of the owner is charged with and subject to the *jus publicum* belonging to Your Majesty's subjects in the same manner as the soil of a highway is, which, though in point of property it may be a man's freehold, is nevertheless charged with a public interest of the people.

See 2 and 3 Will. IV., c. 71, s. 2, Williams *v.* Wilcox, 8 Ad. and El., p. 314.

Comyn's Digest, tit. Navigation.

Bacon's Abridgment, tit. Prerogative.

2 Blackstone's Commentaries, Stephen's Ed., p. 521.

Hawkins' Pleas of the Crown.

Sir Leoline Jenkins, pp. 76, 88, 96.

See Case of Isle of Ely, 10 Coke's Reports, 141.

Rex *v.* Smith, 2 Douglas' Reports, 411.

The Houses of Parliament have passed many Acts entrusting the conservancy of harbours and navigable rivers to certain Commissioners with large powers for that purpose.

Thus the jurisdiction of the Admiralty has by charters and Acts of Parliament been superseded, to the great detriment of the public service.

Having thus briefly recited the present state of the law with respect to the conservancy of our harbours and rivers, adduced a few examples of the want of efficient control in all our ports, and shown the necessity of immediate legislative measures in order to stop the daily increasing evils to navigation, we humbly take leave to lay before Your Majesty the recommendations which appear to us best calculated to meet the cases in question.

Your Commission therefore humbly recommend :—

That a Board of Conservancy be established for the superintendence and protection of all the tidal harbours and navigable rivers in the United Kingdom of Great Britain and Ireland; that it be in connexion with the Admiralty; and that it be permanent.

That this Board have jurisdiction by summary proceedings over the waters of the tidal harbours and navigable rivers, notwithstanding any Charters or Acts of Parliament to the contrary, with a reservation of private rights under the charters, and the continuation of local Commissioners where the Board may think fit.

That the Board should have full powers, by the assistance of engineers, surveyors, and others, to ascertain the extent of all nuisances and obstructions in tidal harbours and navigable rivers.

That the Board should be enabled to have a jury summoned by the sheriff to ascertain whether or not any encroachment or other nuisance in a tidal harbour or navigable river, has existed   years; and if it be found to have been made within that time, that the Board have power by their own order, at the expense of the party who made such encroachment or nuisance, to remove it.

That the whole of the coasts of the United Kingdom be divided by this Board into districts, and that each be placed under the superintendence of a competent person, who shall visit each river, port, harbour, and creek at least once a year, or oftener, as it may be necessary, to inquire into and report on the state of each river, port, harbour, and creek in his district, and of all works which may be in progress there.

That the Board should have power to enforce the appointment of a resident engineer or harbour-master, or both, at every port they may consider of sufficient importance to require such constant superintendence.

That every Commission or Trust of a harbour or navigable river, or if there be none, every resident engineer or harbour-master be required to make out and forward to the Board before the 1st of March in each year, a detailed report made up to the 31st December, consisting of an account of all such works as have been executed, with the expenses thereof, within the limits of his superintendence, during the past year; and a report on those works he would recommend to be undertaken during the ensuing year. And, also, to include in that report an account of all changes that may have taken place during the year in the depth of water, or formation of shoals, or any other change affecting the navigation of the river or harbour.

That if any works, public or private, shall be commenced or proceeded with on grounds within the high-water mark of ordinary spring-tides, without having first obtained the sanction of the Board, or their superintending Officer, it shall be lawful, and the Board should be empowered immediately to stop such works, and to direct the removal of the same by the parties erecting them, and if they refuse so to do, the Board may direct their removal, and charge the parties with the expenses.

That for the protection of the public interests in the navigation of every river, port, harbour, and creek of the United Kingdom, a clause be inserted in every future Act, Charter, or Commission, which affects in any way the tidal harbours and navigable rivers of the country, giving power to, and requiring the Admiralty to appoint one-third part of the whole number of Commissioners to execute the trusts under such Acts, Charters, and Commissions, and also to have the power to change the whole or any of such third part of Commissioners from time to time, as the Admiralty shall think fit, so as to secure at all times a sufficient number at each board or meeting of the Trust, to protect the public interests against any bias or local interests.

That the Lords Commissioners of the Admiralty should direct the surveying officers employed in the seas of the United Kingdom to transmit to them, for the information of the Board of Conservancy, a list of all the parts of the coast on which they have been engaged surveying, and the harbours, ports, creeks, and navigable rivers they have examined, and on which they feel competent to give an opinion, in case of any improvements or alterations being proposed: also, that in future, in every port they visit, they shall make inquiries relative to any embankments or encroachments on the harbour or river, and generally as to any neglect in the preservation of the ports; and forthwith shall report the same to the Secretary of the Admiralty for the information of the said Board.

That, hereafter, the number of Commissioners or Trustees of any harbour or navigable river, docks, or other work affecting navigation, shall not exceed twelve (12), and that four (4) be a quorum, with a view to greater responsibility and the more effectual performance of the duties connected with such Commission or Trust.

That to all existing Harbour Commissions or Trusts the Admiralty shall have power to add new Commissioners or Trustees, not exceeding in number one fourth of the whole Commission.

That the Board should have power to call upon every such Commission, or Trust, or Harbour Master, as the case may be, to make out a correct account of all receipts of money by the said Commission in the course of the year up to the 31st of December; and from what source, and under what authority received; stating, also, the expenditure during the year under separate heads, so as to afford a current account of the resources of each Trust, and of the application of the same; which, after being duly audited, shall be transmitted to the Board of Conservancy on or before the 1st March following.

That the Board should have power to order that a tide scale be placed in all harbours; and in certain ports that a self-registering tide gauge be erected, accompanied by a barometer, and that a record of these be strictly kept; as well as a journal of the winds and weather; of the arrivals and sailings, of cases of wreck, or of any thing affecting the interests of navigation, and transmitted periodically to the Board of Conservancy.

That in all suits and proceedings at law, by the Directors or Commissioners acting under any Commission or Trust of a harbour or navigable river, it shall be imperative on them to take the opinion of, and to act under the directions of the law officers of the Crown.

That a summary of the proceedings of this Board be laid before Parliament on or before the 25th March in each year.

That an annual grant be made by Parliament for the support of the said Board.

Among the last recommendations which we humbly take leave to lay before Your Majesty, there is one which appears to your Commission of essential importance towards the improvement of our harbours, namely, the procuring accurate plans and surveys on a sufficient scale of all the ports and navigable rivers of the United Kingdom; not only for the present value of such plans as showing the actual state of the port, and as affording the basis for improvements; but also to be preserved as documents for reference hereafter, in order to determine at any future time what changes may have taken place.

For farther explanation of various points only briefly touched upon in this Report, we beg to refer to the plans and evidence, and especially to the opinions of the eminent engineers whom we have examined; and also to the various documents contained in the Appendix. Among the latter will be found the opinion of the Commissioners of the Navy, who having to inquire in 1818 into the state of the river Medway, even at that time strongly urged the necessity of a district superintendence along the whole coast of the United Kingdom similar to that we have now ventured to recommend to Your Majesty.

We beg to state that we are proceeding in our inquiry into the important matters submitted to our consideration, and that we shall hereafter submit a farther Report to Your Majesty.

Your Commission cannot close their Report without expressing, in the strongest terms, their conviction that immediate measures for detailed inquiry and local examination into the state and condition of every port and navigable river of the United Kingdom, are indispensably necessary, with a view to that thorough superintendence, without which many of the evils already recited are liable to recur.

And when they consider the great want of accessible harbours along the whole of the coasts of Your Majesty's dominions,—more especially when the extended use of steam navigation points to such great changes in maritime affairs, whereby every sheltered creek is likely to become of value—and when they consider that by the improvement of our tidal harbours Your Majesty's beneficent intentions for the preservation of the lives and property of a large class of Your Majesty's subjects may be best fulfilled, they earnestly trust that no minor consideration may be allowed to impede the accomplishment of objects of such national importance.

All which we humbly certify to Your Majesty.

Wm. BOWLES, Rear-Admiral, M.P., *Chairman.*
J. J. GORDON BREMER, Captain R.N.
JOSEPH HUME, M.P.
AARON CHAPMAN, M.P.
EDWARD R. RICE, M.P.
THOMAS BARING, M.P.
F. BEAUFORT, Hydrographer.
G. B. AIRY, Astronomer Royal.
JOHN WASHINGTON, Captain R.N.
RICHARD GODSON, Q.C. & M.P., Counsel to the Admiralty.

London, 8*th July*, 1845.

MINUTES OF EVIDENCE.

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MINUTES OF EVIDENCE

TAKEN BEFORE

THE COMMISSIONERS APPOINTED TO INQUIRE INTO THE STATE OF TIDAL HARBOURS.

Wednesday, 30*th April*, 1845.

Present:—

Capt. Sir GORDON BREMER, R.N., in the Chair.

Mr. HUME, M.P.	Capt. BEAUFORT, R.N.
Mr. CHAPMAN, M.P.	Capt. WASHINGTON, R.N.
Mr. GODSON, M.P.	

William Bald, Esq., examined.

William Bald, Esq.

April 30, 1845.

1. (*Chairman.*) You are an engineer?—I am.

2. Are you acquainted with the river Clyde?—Yes, I have been acquainted with it since the year 1803, but I was appointed resident engineer and superintendent of the river Clyde under the Clyde trustees in the year 1839.

3. Will you state what has been done in improving the river since the year 1803?—I cannot say that I was particularly acquainted with the navigation of the river from 1803 to 1839. I had merely sailed up and down it. I was not professionally employed to examine it. My connection with the river only commenced in 1839.

4. From 1839 onwards, have you devoted your attention wholly and entirely to that river?—Wholly and entirely. My duties consisted in superintending the whole of the engineering operations of the harbour and river, examining all the accounts, writing out all the reports, and attending all the meetings. In 1839 the greatest barrier that existed to the navigation of the river Clyde was a bank near Port Glasgow called The Port Glasgow Bank; the depth of water there at that period was from five to six feet at extreme low spring tides; the length across the bank was about 700 yards. There was a cut commenced through it in 1841 and 1842, 300 feet wide, and the depth at present is from 10 to 10 feet 6 inches at low water spring tides, being an increase of from 5 to 5 feet 6 inches. At the time of high water high spring tides there is about 22 feet of water.

5. (*Mr. Hume.*) What was there before the cut was made?—Between 15 and 16 feet, being an increase of about 6 feet.

6. How was the cut made?—The cut was made by three dredge boats, one of which had a 16 horse power engine, a 20 horse power engine, and the other 22.

7. Did you make a report upon that matter?—There was a report made.

8. Have you any minute of that report?—No, I have not.

9. On taking charge of the river, did you report what in your opinion ought to be done with a view to improve the navigation of the river?—Yes; that was my first report.

10. Did you afterwards report what you had done?—Yes, I reported upon being appointed engineer for the improving of the river in 1839; that report was printed. There was also a second report printed, which I have not here.

11. What was the date of that report?—I do not remember; it was about 18 months after the first report.

12. Was the manner in which the operation was carried on of cutting the bank detailed in that last report of yours?—It was.

13. What did you do with the material?—It was laid on the shore of one of the small bays.

14. On the main land?—Yes, on the south shore.

15. Was it sand or shingle?—It consisted of the exuviæ and decomposition of oyster shells, and cockle shells, and mud.

16. Did you lay it above high-water line?—No; it was laid in a small bay on the shore side.

17. Why was it not placed above high-water mark?—We could not get ground there to deposit it upon.

18. Have you had those dredging machines in operation since on the same bank?—We were two years upon the bank with them.

19. In the two last years, has nothing been done towards removing the bank?—No, nothing more was required, the channel through it was deep enough.

20. State any other operations that have taken place?—The next bank that was cut through was the Puddle-deep Bank, about two miles higher up. I should observe, that the channel cut through the Port Glasgow Bank has not shown any tendency to silt up; it has been sounded since.

21. What breadth of channel did you cut through it?—Three hundred feet. After the Garmoyle bank was cut through, there was another bank opposite Dumbarton Castle cut through.

22. By the same means?—Yes, by the dredging-boats.

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23. What increased depth of water did you gain on that?—We gained about 2 feet or 2 feet 6 inches; it was deepened to 10 feet at low water. We generally dredge to 10 feet deep at low water; that is our rule.

24. And you maintain 10 feet at low water on the Port Glasgow Bank?—A little more. We have a greater rise of tide in the lower part of the river than we have in the upper reaches of the river.

25. Have you made any observations of the rise of the tide during the period you have been in charge of the river?—Yes.

26. In what way have you made those observations?—By tide staffs, and observations were made night and day.

27. In what way and to whom have you reported your observations?—The result of my observations were placed by me as records in the office.

28. Have you got copies of them with you?—No; the copies are lodged in the office in manuscript. There is an engraved copper plate, and it is on printed sheets taken from that plate that the tides are delineated. *(See rise of tides and velocity of water in Clyde, Appendix, No. 3.)*

29. Can you state what the depth of the water was at Glasgow Quay in 1839, when you took charge, and what the depth now is?—I should say that it was about 14 to 15 feet at high water neap tides in 1839; and now vessels drawing 17 feet of water can come up. From 2 feet to two feet six inches is the additional depth in the harbour.

30. Are you able to state by what means that depth has been increased?—By the dredging power alone.

31. In how many places has that dredging power been applied?—Over the whole surface of the harbour up to the bridge. The parts near the bridge have been 14 and 15 feet deep at high water of the low neaps in the autumn, and in the spring of the year at low water the banks were seen, so rapidly the harbour fills.

32. What other impediments to the navigation have you removed besides those banks?—The next cutting was at Dumbarton Bank; and a shoal at the head of the Long Dyke.

33. What was the nature of the impediment there?—It was a shoal.

34. What depth was there upon it?—I should think about 13 to 14 feet at high water low neaps, and there were other banks also cut through.

35. You have stated that you removed various impediments in the river, what were they—were they principally jetties, or rocks, or piers in the course of the navigation?—There were two jetties partly removed below Erskine Ferry, and above it a parallel dyke on the south side, near 500 yards long; and another parallel dyke was removed on the north side below the Newshot Isle, and a vast quantity of stone boulders removed from the bottom of the channel by two diving bells.

36. Did you lay down any rule as to the breadth which should remain, and the removal of all projections within that breadth?—Yes.

37. What were the rules that you laid down for your guidance?—To preserve a width of 300 feet at the mouth of Glasgow Harbour, and 310 feet at Kelvin River.

38. How far down is that?—1800 yards.

39. That is at the west end of the town of Glasgow?—Yes; and lower down it was to be 322 feet wide, that is 5 miles from Glasgow; and at the mouth of the Cart it was to be 400 feet wide.

40. How many miles is it from the Kelvin to the Cart?—The Cart is about 6 miles below Glasgow.

41. Is there any other alteration as you go down?—Yes, at the west end of the Newshot Isle it was to be 405 feet wide.

42. At Newshot Isle you appear to have taken the channel on the north side of the river, whilst to the south the channel appears not only wider but more direct; why did not you apply the dredge to the south side of the island?—The existing navigation is upon the north channel; the south channel is by far the best channel, there can be no question upon it, but the Trustees were not desirous of interfering with the south channel; they said there was some rock there that prevented them taking that direction.

43. Did you examine to ascertain whether there was any rock?—Yes, I was furnished with a section and borings, and I found that the expense of making that channel would be about 7000*l.*

44. If you had expended 7000*l.*, could you have made the channel straight instead of the circuitous one you now have at the north of the Newshot Island?—Quite easily.

45. Did you make any report to the trustees upon the subject?—I did not make a report to them upon it; I was not ordered by them to do so. I wrote a letter to Mr. Walker about opening it in 1839. *(See Appendix, No. 4.)*

46. Did you recommend that that should be done?—I did in the report laid before the General Trust, in January, 1841, in relation to the channel. It is in these terms:—"My Lord and Gentlemen, before closing this report, I consider it my duty to bring under your consideration the following subject. The Newshot Isle, bounded on the north by the present channel of the Clyde, and on the south by the old channel; the latter is quite straight and direct in its course, and is more than 100 yards shorter than the north channel, through which all vessels now pass in navigating the river; the south channel of the Clyde at the Newshot Isle is 2000 yards long, and contains an area of 486,000 square yards, or about 100 acres of water space, being nearly equal to the area of all the docks in Liverpool. This channel, if cleared out, will hold 34 millions of cubic feet of water. I have to announce that this great and valuable water space is rapidly filling up; and this channel of 100 acres of water, through which vessels formerly sailed will soon become fine meadow land, because both the lower and upper entrances of this channel have been nearly dyked up. My object in laying this matter before you is not for

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the purpose of asking you to embark in executing one of the greatest improvements which is capable of being effected on the whole or any part of the River Clyde as to the directness of the course and line of navigation, and also in attaining an earlier and quicker, and an increased tidal flow upwards; no, I only beg that this valuable channel or sheet of water, containing 100 acres, shall not be allowed to silt up, and become fine meadow land, but that it shall be preserved for navigable and commercial purposes."

47. Was that Report printed?—No, it was not.

48. There appears to be a jetty on the west of the Newshot Island, opposite the property of Mr. John Henderson; at what time was that jetty made?—If it be a jetty, it was made after Mr. Golborne's Report in 1768.

49. How many feet does that jetty project?—450 feet.

50. Is it a solid jetty?—It is quite solid, and consists of earth and stone. It is a pier belonging to Mr. Henderson, of Park.

51. Does not that pier completely fill up the space between the island and the south channel, which would be the direct, and, as you think, the best channel?—It does to some extent.

52. Did you propose to remove any other jetties from the banks of the river?—I proposed to cut a piece off the point of that pier, and to remove all those jetties that lie in the way.

53. By which means you would obtain a straight channel for the tide?—Yes.

54. How did you intend to carry into effect the removing the piece south of the island to which you have referred?—By cutting away the point of the pier, and then removing the parallel dyke.

55. Does that dyke run parallel to the south shore, or parallel to the north shore?—More parallel to the north shore.

56. Was the south channel always the old channel?—In the recollection of several people, vessels passed up and down the south channel.

57. Are we to understand that your object was to re-open that straight wide passage for the navigation instead of the narrow and circular one to the north?—Quite so.

58. Since the representation which you made to the Clyde Trustees, has that channel continued to silt up?—Yes; I was ordered by the trustees to desist from taking away the stones on the parallel dyke. I had a remit or order from the trustees upon that subject.

59. Does this map show, that, from the point of the jetty projecting from the south side, a bank of stones has been thrown to the eastward till it joins the west part of the isle?—Yes; there is now a solid dyke of stones.

60. By which means the tide is prevented running up?—Yes.

61. Taking into account the expenditure of seven or eight thousand pounds, which you consider would be necessary to open the south channel, what would be the value of that channel as compared with the other?—I think it would be the greatest improvement that could be effected in the river.

62. Would the flow of the tide then be straight, and in a continued line?—Yes.

63. Instead of being in a line circuitous to the north?—Yes; measuring the velocity of the tidal-wave. It is found to run from Port Glasgow up to Bowling about 13 miles per hour; and from Bowling, on account of the channel being so crooked up to Clyde Bank, the run of the wave is not more than about 6·40 miles.

64. Do you consider that that decrease of the flow of the tide is owing to the channel going in that circle round the north of the island?—There can be no doubt of it; for this reason,—that again from Clyde Bank up to Glasgow the tidal wave runs at the rate of 10 miles an hour; it increases after it has passed the curvature.

65. (*Capt. Washington.*) Are you not aware that there are other circumstances than curvature, such as depth of channel above or below the place, which may influence the velocity of the tide?—No doubt the tidal wave will be quicker in the deep channel; but I think that the diminution in the velocity to 6·40 miles between Bowling and Clyde Bank arises from the crooked channel round Newshot Isle.

66. Is the channel the same depth all the way?—Nearly the same depth all the way.

67. Are you aware of any other impediment which would prevent the flow of the tide except that curvature?—I am not aware of anything else; and I was so impressed with this, that a paper was read by me before the British Association on the tides and the improvement of that part of the river.

68. (Mr. *Hume.*) At what date?—At the Glasgow meeting in 1840.

69. Do you give the accurate details in that paper from your experiments?—Yes I do.

70. Will you read the order which the trustees gave you to desist from removing the dyke?—In 1842 I began to take away the parallel dyke; I did that of my own authority, and I received this remit from the Committee 27th of July, 1842. "The committee of management of the Clyde trustees being assembled, there was laid before the Committee the following letter from Mr. Henderson (here it is quoted, it is in the minute of the trustees), which letter having been considered, the Committee direct Mr. Bald to discontinue the operations complained of, and to have a conference with Mr. Henderson on the subject, so as to satisfy him that no injury will be done to his quay, preserving always the rights of the trustees under the statute. Extracted from the minutes of the trustees, John Macfarlane."

71. Did you have any conference with Mr. Henderson?—No, nothing definite; I could make nothing of Mr. Henderson. This was in 1842. Considering it of so much importance to open this channel, I again, under my own authority, began to remove this dyke in 1843, and we took about twenty punt loads of stones from it, when Mr. Henderson addressed this letter to me. "Glasgow, 18th August, 1843. Dear Sir,—I beg to prefix a copy of a letter which I have this day sent to the river trustees, and to which I refer you. I hope you will feel it your duty to desist from further operations on the dyke until the trustees have considered my communication.

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If you do resolve to proceed, I hope you will at once say so, that I may protect myself by an interdict. Yours truly, John Henderson." Addressed to William Bald, Esq.

72. Did you begin on the dyke parallel with the river, or on the jetty?—On the dyke parallel with the river; I did not wish at that time to meddle with his quay, but only to get the dyke away.

73. Where did you begin your operations?—Near the middle.

74. Is not that dyke almost in the centre of the river?—It is nearly in the centre of the river between the north and south shores; it is a little more to the north.

75. Do you understand from that letter that Mr. Henderson claims his property to the centre of the river?—I do not consider that the dyke is his property, nor do I consider that the part coloured blue is his property; it is the surface of the river.

76. Did you begin to take down part of the dyke in the centre of the stream?—Yes, in order to keep the channel clear to preserve the depth.

77. What followed upon that letter?—I received a remit, which I hold in my hand. "At Glasgow, 25th day of August, 1843. The committee of management of the Clyde trustees being assembled there, was presented a letter from Mr. Henderson of Park, complaining of the removal of some stones from the dykes opposite to the lands of Park, which letter having been considered, the Committee direct Mr. Bald to discontinue any further removal of stones from these dykes, and an answer to be returned that instructions have been given to the said effect. Extracted from the minutes of the trustees by John Macffarlane."

78. (*Capt. Washington.*) Can you tell us when and by whom the dyke was formed?—By the Clyde trustees. I believe the late John Rennie, Esq. laid down the designs for the parallel dykes of the Clyde; but I found the designs of that able engineer had not been carried correctly into execution. For example, in one of his Reports on the improvement of the Clyde, dated 27th December, 1807, he states that the Clyde should be at Dunglass Castle 536 feet wide. Now between Dunglass Castle and the existing parallel dyke it is only now about 400 feet wide, and which is and has been highly injurious to the tidal flow and the navigation, and should have been widened even more than Mr. Rennie had recommended.

79. Are there minutes in the books of the Clyde trustees, giving to Mr. Henderson the land on the south side?—I rather think not.

80. Is there not a report by Mr. John Rennie at that time of his operations in the Clyde?—There is.

81. Do you understand that those dykes, at the time they were made, were made under the impression that they would improve the navigation of the river?—Yes.

82. (Mr. *Hume.*) But in your opinion those dykes so constructed have injured, and continue to injure, the navigation?—I will not take upon myself to say they are all injurious, but I think the channel between the dykes was made too narrow; it should have been made much wider. The parallel dykes had a beneficial effect in deepening the Clyde, but in my opinion there has not been sufficient width preserved in the channel of the river to let the tide flow up and down, and particularly at Dunglass Castle, and shutting up the south channel at the Newshot Isle, &c.

83. With respect to jetties or piers advanced 450 feet from the southern shore, are you of opinion that parallel dykes so placed have been beneficial or injurious?—I should think them injurious.

84. At what level are the parallel dykes made?—Nearly to the level of high water.

85. Are you not of opinion that every impediment to the flow of the tide upwards is an injury to the navigation?—Quite so.

86. Then is not that dyke an impediment to the flow of the tide?—There is not the least doubt of it.

87. Why then do you hesitate to say that it is not injurious to the navigation?—At that particular point it is injurious to the navigation to have a dyke across the mouth of such a channel, but in other parts of the river I think it is beneficial to have parallel dykes.

88. You have stated that in two successive years you began to pull this dyke down without orders and against orders; if you did so, what was the object you had in view—was it not to improve the navigation?—Yes, it was to let more water flow up into the river by taking away that obstruction.

89. Are those dykes at right angles with the course of the river, or do they run parallel with the current?—They run parallel with the current, and the jetties are generally at right angles to it.

90. If those dykes and those jetties are allowed to remain, is it not your opinion that this channel south of Newshot Island will soon be silted up?—Yes, I think so; the reason why I stated that in the Report was, that unless I had done so, hereafter the trustees might say, "You have been on the River Clyde for 20 years or 15 years; did you ever make an attempt to open up the south channel of the Newshot Island, in order to let up more tidal water; have you ever exerted yourself to prevent it becoming green ground?" and that was the reason I was so anxious to do what I did.

91. In what other places did you remove impediments?—I removed the weir at Glasgow Bridge, but that was under the authority of the trustees.

92. What was the height of that weir?—There might have been from three to four feet water on the top of it at high water.

93. What was the height of the weir at low water?—Three to four feet.

94. Has the removal of that weir in your opinion been productive of any benefit to the navigation?—Only so far as to let a little more tidal water up to Stockwell-street Bridge, but it has been most valuable in affording harbour accommodation to the small craft and timber rafts, and which accommodation should be extended up to near Stockwell Bridge, and which is much required.

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95. At Stockwell-street Bridge is there any impediment to the flow of the tide upwards?—A very serious impediment.

96. What is the nature of that impediment?—It is the weir that has been made across the bed of the river to protect the foundation of Stockwell Bridge.

97. At what time was that made?—That bridge has been in existence for 500 years.

98. Is it your opinion that that weir stops the flow upwards to any considerable extent?—To a very considerable extent.

99. Beyond that, would there be any other impediments if that weir were removed?—There is a small shoal of sand and shingle at Hutchinson's Bridge, a little higher up.

100. Have your dredging boats been employed above any of the bridges?—Yes, above Glasgow Bridge, between Glasgow Bridge and the Wooden Bridge.

101. What depth of water have you gained there?—About four or five feet additional depth of water, but it is only upon a small portion between Glasgow Bridge and the Wooden Bridge; the whole should be deepened up to near Stockwell Bridge.

102. (*Capt. Washington.*) What do you consider the highest flow of the tide up the river?—The highest flow of the tide extends above the Glasgow Waterworks, and which is four miles and a quarter above Glasgow Bridge, at the point marked upon that plan; the ordinary tides only reach Dalmarnock.

103. (Mr. *Hume.*) Between Glasgow Bridge and the point that high water reaches, what other impediments exist?—I know of none.

104. Then if the weir at Stockwell-street Bridge was removed, do you consider that any great increase of water would flow up?—Yes, very considerable.

105. What would be the effect of that in deepening the water at the quays?—About from 20 to 30 millions of cubic feet of water would ascend up to about four miles above Glasgow Bridge, and that would have a very beneficial effect in scouring the deposition which flows into the Harbour of Glasgow from the common sewers of the city.

106. That shoal which you mention as being between the two bridges, if there was a free flood, would be swept away by that flood?—I think the current freshes of the river would sweep a great part of it away.

107. With the assistance of the dredging machines?—Yes; it is fine sand and gravel.

108. (*Capt. Washington.*) How high does the tide now go up beyond the bridge?—It goes up four miles and a quarter at very high tides above Glasgow Bridge.

109. How much higher would it go, if these weirs were removed?—I think something higher; I cannot tell how much higher.

110. Have you taken the levels in the higher part of the river?—Yes, we had the levels taken all up the river.

111. (Mr. *Hume.*) Are you able to furnish us with the levels of the river, in order to show what the depth of water was at the time when you took charge, and what it is now, and also to what extent it would go if those impediments were removed?—Yes, I can furnish those details.

112. If those impediments at Stockwell-street Bridge were removed, what would be the increased depth of water at Glasgow Quay?—I am not exactly prepared to say we should have an additional depth of water in the harbour, but we should have an additional scouring power of 20 or 30 millions of cubic feet of water ascending up into the higher reaches of the river, and that would have a beneficial effect in preventing the formation of banks and shoals in the whole river downwards.

113. Would not that of necessity deepen every portion of the river?—Yes, it would have an effect upon the banks and shoals down to Greenock.

114. Upon what data have you formed the calculation that from 20 to 30 millions of cubic feet of water would be obtained?—The calculation I have gone upon is this; the length of that part of the river line is 22,640 feet, the breadth is 214 feet, and the average rise of the tides taken at 6½ feet will give 31,492,240 cubic feet of tidal water.

115. Are the Commissioners to understand that that weir at Stockwell Bridge is the impediment to that increased flow, or are there any other impediments?—There are no other impediments that I know of, except the small shoal at Hutchinson's Bridge, which I think would be scoured away by the currents if the weir at Stockwell Bridge were removed.

116. In your opinion is that weir necessary to support the bridge?—At present it is absolutely necessary to support the bridge.

117. Is it not the intention to remove that bridge?—There is a bill now before Parliament to take down that bridge, and to build a new bridge.

118. (*Capt. Beaufort.*) How much water-way does that bridge take from the stream?—I have not the documents here which would enable me to say.

119. Is it considerable?—No; there is plenty of room for the water-way, the present old arches are amply wide for the flow of the water.

120. How many arches are there?—Six.

121. Are they thick piers?—Not very thick.

122. (*Capt. Washington.*) You have stated that you have gained an additional depth of between two and three feet at the quay, what observation have you made with respect to the difference in the high and low water levels?—In consequence of the cutting away of the bank at Port Glasgow and all the lower banks, the tides are now lower in the harbour of Glasgow than they were in 1839.

123. Is there any difference in the time of high water at the bridge?—The last time I tried it was by means of two chronometers, and it gave me 10 or 15 minutes sooner in the harbour than formerly.

124. And you have the water lower now than formerly?—Yes.

125. Consequently the scour that takes place is augmented by the increased flood as well as the increased ebb which you also have?—No doubt.

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126. (Mr. *Hume.*) Are you aware on what authority that weir at Stockwell Bridge was erected?—When the weir at Glasgow Bridge was removed the Clyde Trustees were bound by Act of Parliament to sustain the level of ordinary low water above Stockwell Bridge for the Glasgow Water Company; and those works constructed for that purpose have been reported to amount to about 3000*l.*

127. Do those works belong to the Corporation or to any public body, or any private Company?—They are for the benefit of the Glasgow Waterworks Company.

128. Consequently the public. who have lost the benefit of the river, have not benefited by the profit of the Water Company?—No, except the additional space from Glasgow Bridge to Stockwell Bridge, when it shall have been all deepened.

129. (*Capt. Washington.*) Supposing you removed that weir, would not Glasgow lose its water entirely? Would not that removal entirely deprive Glasgow of fresh water?—No, the bed of the river might be secured at Dalmarnock Ford.

130. How much above Glasgow Bridge?—About three miles, that is at the point to where the ordinary tide now flows.

131. Would that have the effect of keeping up a quantity of water for the supply of Glasgow?—It would.

132. Where do all the chemical processes and manufactories that go on in Glasgow draw their water from?—Principally from the Glasgow Water Works. There are some manufacturing places that have their pipes laid into that part of the river between Stockwell Bridge and Rutherglen, but it would be easy for them to lower their pipes, and still supply themselves.

133. Pipes could be easily put down even if the weir were removed?—Yes.

134. But at present they draw clear Clyde water, do they not?—They draw the water such as it is.

135. If you allowed the tidal water to go up, and that kept the water of the river back, do not you think that those pipes would draw up that water, rendered impure by the filth of the town, into the manufactories?—It would, but only to the few places between Stockwell and Rutherglen.

136. (Mr. *Hume.*) Up to what point does the salt water come?—In the dry season of the year no salt water is to be found in the upper reaches of the Clyde. Water slightly salt has sometimes been perceptible at Renfrew, that is nearly 6 miles below the city.

137. Are the Commissioners then to understand that between the point which you point out as the spot from which water might be drawn for the supply of the city and for all other works, and the point where the water becomes salt there is a distance of 10 miles?—It is more than 10 miles; the waterworks lie principally above Dalmarnock, except the Cransten Works, which lie below it a little.

138. In the operations which you have carried on of dredging and emptying, what quantity of materials during the year have you taken out of the river?—About 300,000 cubic yards now annually; there has been taken out during the last six years from the bed of the Clyde about 1,481,050 cubic yards of stuff. *(See Appendix, No. 3.)*

139. Do you include in that the stuff taken out of the Port Glasgow Bank?—Yes. The Port Glasgow Bank and the other banks.

140. You have not meddled with the Cockle Bank?—No, that is a dry bank, and the other is never dry.

141. Is Cockle Bank dry?—It is every tide at low water.

142. What has been the effect on the navigation since that increased depth of water has been obtained as to the number of ships that formerly resorted to the towns of Port Glasgow and Greenock coming up to Glasgow?—The trade of the harbour has manifestly increased wonderfully within these few years. In consequence of the increased depth of water vessels of a larger description, East and West Indiamen, have all come up the river without any difficulty.

143. Have ships of a size, obliged formerly to unload at Greenock and Port Glasgow, been able in consequence of that improvement to take in and deliver their cargoes at the city of Glasgow?—Yes.

144. Are you able to state what proportion of the trade that would be?—No, that is in the harbour-master's department.

145. Is it your opinion that if all the impediments which now prevent the flow of the tide up to the spot which you point out as the high-water mark, 4¼ miles above the quay were removed, the water would be still further deepened so as to allow ships of any size employed in the foreign trade to come up to the quay at Glasgow?—Yes.

146. What is the depth of water at low-water mark?—I should say from 10 to 12 feet.

147. Then large ships would lie a-ground?—No, the bottom of the harbour of Glasgow is remarkably soft stuff, and they are almost water-borne; they lie on a soft bottom.

148. Is there any place on either side of the harbour at Glasgow adapted for wet docks, in which ships of a large size could lie afloat?—About 400 yards west of the bridge, on the south side, a basin or dock has been proposed. It is in the plan, consisting of about 6¼ acres of water space capable of holding about 60 ships of 400 tons.

149. Have you ground sufficient for that basin?—Yes, we have; but to make it a floating basin there would be considerable engineering difficulties to be encountered on account of the porous nature of the strata. I apprehend that when the water would be locked in, it would sink and escape. The best thing that could be done would be to make it a tidal basin. It might be made 15 feet deep at low water; and it would be a most useful and valuable ship basin. It was recommended by the late eminent engineer, Mr. Rennie; it has also been recommended by Mr. Walker, and laid down in his plan of the Clyde. The rise of the tide in the harbour of Glasgow not being more, at an average, than from 6 feet 6 inches to 7 feet; it does not become altogether so necessary to have an impounded basin of water to float ships. But on the north side, on the lands of Stobcross, there is ground inviting for the construction of a wet dock or a tidal harbour.

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150. To whom does that land belong?—It has been purchased lately by a company of gentlemen, some of them river trustees.

151. For what purpose?—I do not know. This is a plan of a harbour which I designed and drew out in 1840, containing 60 acres of water surface opening into the river and proposing the extension of Argyle-street down to it.

152. Would that have admitted of docks such as you have alluded to, capable of holding ships of a large size?—Yes, it would have been ample for the purpose; and also for dry docks, which are much wanting.

153. What depth of water could you have?—Any depth that might be required—18 or 20 feet, or more if necessary, by excavation.

154. Is the soil better there than at the south?—Yes, but I do not say that it would be water tight.

155. Is there any mode by which a dock of that kind could be puddled as canals are puddled?—It could be done. The expense is the only thing, and also the risk.

156. What difficulty would there be in puddling the other side—the south side?—It could be puddled in the bottom and sides, but it would be attended with considerable expense.

157. (*Capt. Washington.*) Are the London or Liverpool Docks puddled?—I do not know; those at Dublin were puddled. The quay walls would require to be all piled in Glesgow Harbour, and also those which would be built round any new basins or docks.

158. (Mr. *Hume.*) Beyond those impediments which you have mentioned, are there any others which prevent the increased flow of water in the Clyde?—The river Clyde at present is too narrow. It should be widened, and all the points in the river between the harbour of Glasgow and the mouth of the Cart river should be cut off, which would greatly increase and improve the tidal flow, and also the navigation, and which is pressingly required by the shipping trade.

159. Have you not been employed for the last two years in cutting off those points?—During the last two years we have made an addition to the harbour of about 7½ acres, and we have cut off the point on the north side from the Kelvin east; and plans and estimates have been made for cutting off the points at Over Newton, Fairfield, &c. &c., and plans have been made for cutting off various points lower down.

160. Are there any objections to that being carried out now?—None.

161. What has been done with all the materials which have been taken out from the bed of the river; have they been laid on the land, or have they been laid on the alveus of the river?—Partly on the land and partly in the bays or creeks of the alveus of the river.

162. Do you not consider it objectionable to lay the material on the alveus of the river?—Highly objectionable.

163. Why then was it done?—We had no other place to put it, except in upon the shore creeks of the river; in the upper part there was no material put down on the alveus of the river, only in the lower parts of the Clyde, where the water space was wider than required.

164. Then in deepening and clearing the river, you have laid out the materials taken out of the river on the alveus, even to the injury of the river?—To the injury of the tidal water to a small extent; but in doing so, I have generally filled up the little creeks or bays, straightened and improved the line of the river, so as to allow the tide to flow along the land without interruption.

165. But do not all those fillings take up from the area over which the tidal waters would flow, and does not that consequently prove an impediment to the flow of the water?—I do consider it highly injurious to any river to shut out even one inch of the tidal water. I think that no deposit should be made below high-water mark, but that it should all be laid beyond it, in every case, except in so far as cutting off projecting points, and filling up indents, so that the water flow freely up.

166. Are the Commissioners to understand that in many of these arrangements you have been obliged to yield to circumstances either from the orders of the Board, or from difficulties which you were unable to overcome?—Difficulties which I have been unable to overcome, on account of the immense expense.

167. As an engineer, if you had been allowed to exercise your own discretion, you would have removed the material beyond the alveus, or limits to which the high water would at any time have come?—I would have done so, but the trustees did not exercise any jurisdiction over me with regard to the deposition of the stuff; they allowed me to lay it where I best could, and did so in the least expensive way.

168. If the trustees left you free to act in the way you thought best, why did you not preserve the alveus?—The alveus were not filled up by this deposition, but generally speaking the creeks and little bays were filled up, in order to straighten and improve the line of the river.

169. Have you found any difficulty in carrying out the plans, which you, as an engineer, judged necessary to improve the river, from the interference of the trustees or any other parties?—I do not know of any interruptions that I have received beyond that which I have referred to.

170. Do you consider that the navigation of so important a river as the Clyde should be left to local powers, without a superintending control from an independent and superior authority?—I am clearly of opinion that such an important navigation as the Clyde should be placed under an independent control, and removed altogether away from local interests of every description and kind.

171. Of whom are the Clyde Commissioners now composed?—"The Lord Provost, 5 Bailies of the city, 1 Dean of Guild, 1 Dean Convener, 15 Members of the Town Council, 1 Chairman of the chamber of Commerce, 3 from the Merchants' House, 2 from the Trades' House, 2 from the Barony of the Gorbels, 1 Provost of Calton, 1 Provost of Anderston, in all 33 members."

172. Are not those gentlemen principally merchants, and persons interested in property on the banks of the harbour, and in the quays and other parts belonging to them?—The Clyde

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Trustees are interested, many of them, in railway and water-works, and they are merchants, and connected with land, &c. &c.

173. Have any instances occurred lately where propositions have been made to interfere with the quays against your opinion as an engineer?—Yes.

174. In what case?—The Union Railway Company wished to occupy 2000 yards—the whole of the north side of the Harbour of Glasgow, and to have coal steaths erected, and it was proposed that that Union Company should purchase the right from the Clyde trustees. I reported against it, as well as the Harbour Masters.

175. Have you copies of your report?—Yes; and I now hand in one printed.

176. What injury, in your opinion, would be done to the port by that measure?—I think it would materially interfere with the East and West India trade, and with the North American trade, and with the Harbour of Glasgow. It would convert the greater part of the north side of the harbour into a coal basin.

177. Is not the northern side of the harbour employed at present by the West India trade?—By the American trade, and by the merchant vessels from the East Indies, from China; they discharge their cargoes on the north side.

178. Would it interfere with the wharfs and warehouses where goods have been usually lodged from those vessels?—I think railways crossing the quays might materially interfere with the general traffic.

179. Was your objection limited to the quays, or was it connected with the navigation?—My objections were founded upon this; that I thought the quays belonging to the harbour should not be occupied by any Joint Stock Company, and that a Joint Stock Company should not have any right to any part of the water-way of the Harbour of Glasgow, or to the streets of the quays.

180. Has your recommendation been attended to?—No, I think not; I think the trustees determined themselves to lay rails upon the quays.

181. Which you consider will be an injury to the port?—I should certainly think that it would be to the general traffic to be crossing with goods from these railways; but stone tramways, level with the streets of the quays, might perhaps be found useful in carrying heavy machinery, &c.

182. You are not prepared to say that any injury to the navigation of the river would arise from it?—The Clyde trustees should not give any Joint Stock Company the power of putting down coal steaths for loading coals, and of occupying 1300 lineal feet of the harbour, it would be highly injurious to the American, East and West India trade in the Harbour of Glasgow. But a coal basin for the shipment of coal might be formed below the harbour.

183. Has one of your objects been to make the port of Glasgow the harbour for the foreign trade, which hitherto has been divided from the want of depth of water at Glasgow, between Glasgow and Greenock?—Yes.

184. What experience have you had in other tidal harbours and water communications?—I extended a pier at West Port for the Marquis of Sligo. I was also employed by the Board of Works to report upon the improvement of the navigation of the River Boyne, in Ireland, and the Port of Drogheda.

185. In what year?—In the year 1831 and 1832; that navigation and harbour remained under my charge for a period of six years, and received great improvements; I had a dredging boat there.

186. Did you carry out upon that river the same principle that you carried out on the Clyde?—Yes.

187. Were great benefits derived at the port by that means?—Yes.

188. Are there any accounts of the benefits derived from those operations on the Boyne?—Yes, they are with the Boyne Commissioners in Ireland.

189. Does your recollection serve you in what way the improvements to which you allude were beneficial?—The depth of water was considerably increased, and the trade of the port was also consequently increased. The plans of the improvements have been published by the House of Commons, connected with the public works of Ireland.

190. Did your plan of deepening the river, and removing impediments, receive the approbation of the Commissioners at the time?—Yes, here is a letter in which they state that they highly approved of the manner in which I had carried out the improvements.

191. Will you state what change took place which induced you to leave the Boyne?—I continued in the employment of the Boyne Commissioners as long as they required me, till the whole of their funds were expended; and the resident engineer, whom I had recommended there, Mr. Young, still remains with them carrying out the improvements, he having acted under me during a period of six years.

192. Have you been in communication with him since to know whether he has continued your plans of improvement?—I understand that the plan which I laid down is exactly the plan which he is now carrying out.

193. And that plan is the plan you have acted upon in the Clyde?—Yes, it is the same in principle.

194. From that where did you go to?—I laid out a plan for the improvement of the navigation of the River Moy in the west of Ireland. The plan passed both Houses of Parliament, but having left Ireland at that period to join the Clyde, I am not aware how far they have carried out the operations proposed.

195. What other experience have you had?—I planned a harbour in Tramore Bay in the south of Ireland; I also carried through in 1836 a plan for the improvement of the river Suir in the south of Ireland; I lately drew two plans for the improvement of the harbour of Troon, and the wet dock that is now being carried into execution.

196. Under your superintendence?—I am occasionally consulted; it is according to the

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plans which I laid down; Captain Manyard occasionally consulted me about it. I was also consulted at Belfast when it was proposed to throw a dam across the river in order to make a still water harbour to the quay by shutting out the tide; my opinion was directly opposed to that, and that plan was given up, and the tide left to flow up to the town, as it now does; and that was carrying out the principle which I have since carried out in the Clyde. I fully agreed in the plan proposed by Mr. Walker at Belfast, of allowing free egress for the water. Last summer I got plans and sections and charts made for the improvement of the river Foyle at Londonderry in Ireland; it is a tidal river; those plans and sections and reports were sent over to the Commissioners for the improvement of that river. I have not heard whether they have carried them yet into execution or not.

197. Those plans were founded on the same principle of removing every obstacle to the flow of the tide?—Yes, cutting off the points of the river, cutting out the shoals, widening the river, and deepening it, and inviting a larger tidal flow up into the country; it is the principle I have universally acted upon.

198. Have you had any other experience?—I was employed by the Lord Provost and Town Council of Perth to defend the river Tay from the invasion made upon the tidal way by the Earl of Zetland two years ago. I gave my aid and advice to repel the invasion, and the Lord Provost and Town Council of Perth were successful in a law suit instituted for the removal of the obstacle.

199. Did not that obstacle consist in dykes thrown out similar to those which there are in the Clyde?—Yes.

200. And by the decree of the Court of Session the Earl of Zetland has been compelled to remove them?—Yes.

201. Were you examined as a witness on that trial?—Yes, and I bored the Tay and discovered that the very dyke works which the Earl of Zetland had constructed were upon a portion of the ancient channel of the Tay.

202. Do you mean that there were stones on the old soil?—There were stone works and embankments pushed out from the land upon the tidal way, shutting out the tide.

203. Did your evidence maintain that all such encroachments from either side tended to stop the flow of the tide towards Perth?—Yes, there is no question of it, they were injurious to the navigation.

204. Do not you attribute the great benefit derived in the navigation of the Clyde to the dredging?—I do; I consider that the great depth of water obtained in the River Clyde has been mostly from artificial means, and that principally by dredging; there are five dredging boats with steam-engines. The parallel dykes laid down by the late Mr. Rennie improved the navigation of the Clyde considerably; and some of the jetties laid down by Mr. Golborne were useful, and some injurious.

205. From your extensive experience have you found that local influences have very much interfered with that which is a national object, keeping rivers clear?—In every case I have found that to be so.

206. Is it your opinion that that department of the Government devolving on the Admiralty should be placed on a footing to enable the Admiralty to take cognizance of every encroachment of whatever kind within high-water mark, whether on sea-shores or other rivers?—That is my opinion decidedly, that it should be under the jurisdiction of the Admiralty; I would place under a superior authority every tidal harbour and every tidal river, and all invasions which are made upon the sea should be resisted wherever tidal harbours or tidal rivers were concerned.

207. In visiting those various places, have you been able to satisfy yourself that every encroachment that you have found has been injurious?—In every tidal river that I have examined, I have always found that wherever an encroachment has been made upon the sea, it has been injurious to the navigation for this reason—that it shuts out the tidal water, and hence it is a loss of the tidal scour necessary to preserve the navigation.

208. Have you found that the proprietors of land adjoining, and the proprietors of wharfs for their own individual interest, have thus encroached on what ought to be left a highway for the commercial navy of England?—I have; I am thoroughly convinced that there are injurious invasions making at this moment upon many of the tidal harbours and tidal rivers on the shores of Great Britain and Ireland.

209. Have you visited lately the Firth of Forth, opposite where an encroachment has been made of many hundred acres, and where an enclosure is now going on to a great extent?—I have heard of that, but I have not examined it; but I am aware that such a thing is going on, and also in the Bay of Belfast; where 2500 acres are proposed to be embanked; and in Lough Swilly there have been embankments made, and also in Lough Foyle. I believe the extent of the embankment proposed there amounts to not less than 20,000 acres, but I have not seen the plans.

210. Have you been on the spot?—I have been over part of Lough Foyle and Lough Swilly.

211. Have you been able to form any opinion as to the amount of injury that would arise?—I have warned the Commissioners of Londonderry, who are the conservators of the River Foyle, of the great danger that would result from the shutting out of the tidal waters. I have used the most emphatic language possible in my Report, with a view to impress upon them the necessity of endeavouring to oppose all such invasions of the tidal way. The Foyle is like a gulf; and by shutting out such a vast quantity of tidal water, the consequence will be, that the mouth of the harbour will become barred.

212. Have you any acquaintance with any harbours to the southward?—I have been lately in the Tyne; and there is a large lake, Jarrow, which they propose to embank in, but I think it would be highly injurious to that navigation if it were embanked, and I gave that as my opinion on the spot to several gentlemen.

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213. Is not that plan brought in by persons who are appointed as Commissioners to protect the navigation?—I believe it is.

214. Can you give any information as to the actual encroachments within the last 50 years on the Clyde?—Yes: the oldest map that I know of the Clyde is the one executed by Mr. William Kyle, of Glasgow, in 1800. This map exhibits 219 jetties, which jetties were commenced in 1768 by Mr. Golborne, the engineer. I consider those jetties to be valuable, in showing the extent of the ancient high-water mark of the river Clyde; because, by uncovering them, we may ascertain how far back the tide originally flowed at high water, and in that way the whole of the ancient alveus or border of the Clyde might be accurately laid down from a survey upon a map, and the extent of the invasion on the river ascertained.

215. Have the spaces on each side of those jetties,—that which was alveus before, become fine solid land?—They have become, to a great extent, fine solid arable and pasture land.

216. Consequently they have diminished the tidal flow to the extent of each encroachment?—No doubt of it.

217. Would any benefit be derived to the navigation by removing any portion of those jetties, if it should appear that they were not legally erected?—I think very great advantage would arise by increasing the tidal flow and improving the navigation.

218. What height did the tide rise over those alveuses?—I cannot say, but they were originally all covered by ordinary tides.

219. If those impediments narrowed the navigation, would they not strengthen the current so much there as to give a greater scouring power?—Yes; wherever a river is narrowed it will increase in depth, because the velocity of the water is increased: but then, on the other hand, the Clyde has been too much narrowed, and, consequently, its tidal flow has been greatly diminished. It might be greatly improved by opening it fully and properly up; and removing many of those parallel dykes, points, jetties, weirs, and other impediments and obstructions which now exist, to the great injury of the navigation; you would then have a greater tidal flow higher up, and, consequently, there would be less expense in dredging in the harbour of Glasgow, and less expense of dredging down along the river. At present, the deposit in the harbour at Glasgow amounts to about 80,000 cubic yards annually. At Bowling, 10 miles below the harbour of Glasgow, a bank annually rises, which requires to be dredged out, which I estimate at from 60 to 70,000 cubic yards. I calculate that, to keep the river Clyde clear at present, and the harbour at Glasgow, requires an annual dredging amounting to about from 160 to 180,000 cubic yards.

220. Would not that amount of deposit annually decrease in proportion to the increase of flow upwards?—Quite so; and it would lessen the expense of dredging.

221. Though a narrow channel quickens the current and deepens the passage of the water in the immediate place, does it not tend to stop the flow to the upper part of the river, and, consequently, injure that part though it may benefit the other part of the river?—No question through a narrow channel less water will flow up, and with a wider channel a greater quantity will flow up.

222. Then you are of opinion, that every impediment which stops the flow to the highest possible point to which the water can reach in the highest tide ought to be improved?—That is my opinion.

223. Every impediment to the effecting of that object is an injury to the navigation, interfering with it, and causing expense to keep it open?—No question of it.

224. What is the depth of the water in the North Newshot Isle Channel at low-water springs?—It runs generally from 9 to 10 feet; that is, on the north channel, the channel in which ships sail.

225. If you disused that channel, and allowed water to flow through the south channel, would not that north channel tend to fill up?—I think not; we would have two mouths, and we would have a greater quantity of water flowing up more quickly.

226. If your attention was directed to the dredging of the south channel and keeping it open, it would be of less importance whether the northern channel silted or not?—It would, because the southern channel being more direct, would form a much better navigation than the north channel, and much more inviting for the tidal flow of water upwards.

227. Then from your extensive experience do you recommend that an authority paramount to all local boards should be placed in the Admiralty, or some competent officer as conservator of the rivers and tidal harbours of the country?—I am clearly of that opinion; I do not think that either the interests of tidal harbours or of tidal river navigations ever will be attended to unless the whole are placed under a Board such as the Admiralty, acting immediately under the Crown; and I think that no local interest should have anything to do with the preservation of those great tidal rivers and tidal harbours,—that all local interests should be entirely excluded from their management.

228. Would your superintendence extend to every act of legislation in which navigation is in the least degree interested; would you extend your supervision to the watching of all navigations connected with every tidal harbour?—Yes, every tidal harbour and every estuary and tidal river, I would place the whole on the same footing that the Government of France have placed their highways; I would place them under the Admiralty, immediately acting under the Crown, and remove it entirely from all local authorities.

229. You have been in France?—I have; I resided four years in France.

230. Can you state what is the system on which the French Government act in respect to their harbours and navigable rivers?—The whole of the large tidal harbours and navigable rivers of France, so far as I understand, are placed immediately under the Government of France, and under their own engineers, in the same manner as the roads and bridges. The Breakwater and Basin at Cherbourg were executed by the Government engineers. The

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improvement of the harbour of Dunkirk, one of the most extraordinary engineering schemes, and the most successful which had been executed in France, and which annoyed the trade of England to an enormous extent, was executed by the French Government. In 1706 it enjoyed a most flourishing trade, and during the war which terminated in the Peace of Utrecht, its privateers took 1,614 English ships, value 1,334,375*l*. At the treaty of Aix-la-Chapelle, England insisted upon the demolition of the harbour of Dunkirk, our trade and commerce having suffered so much.

231. Are you acquainted with St. Malo?—I have not been there since 1826.

232. Are you aware that there are some extraordinary works there?—Yes.

233. Do you think this system of superintendence in France, with respect to harbours, works well or ill?—I am not sufficiently acquainted with the local details to answer, but I have not the least doubt that such a thing, if done in Britain, would work remarkably well.

234. The Commissioners understand you to state that in France no local influences are allowed to interfere with the erection or the management of large harbours?—None.

235. The Government employ their own responsible engineers?—Yes, and take the whole management into their own hands.

236. Is it your opinion that in the erection of all harbours, and any improvement that may be proposed here in England, a Government engineer should be responsible that their execution does not interfere with the navigation?—I am decidedly of that opinion.

237. Do you consider that one engineer would be sufficient in Great Britain for the whole country, or would you propose one for England, one for Scotland, and one for Ireland?—I am not able to answer that question without much consideration.

238. Do you not consider that, in order to guard against future encroachments, some office under the Government ought to be possessed of minute plans of every harbour and creek in this country?—I consider that one of the most useful things that could be done by a maritime nation, would be to collect plans of all the harbours and ports. The wealth and strength of Great Britain depends upon her commerce; and accurate maps and plans of all the ports and harbours would be most valuable as regards their improvement and preservation.

239. You are aware that there have been propositions made to the Government to expend a very considerable sum in providing for harbours of refuge?—I am.

240. Do you not think it of equal or even more importance that the natural harbours of this country should be improved to the greatest possible extent?—I am clearly of that opinion.

241. Are you of opinion that the application of small sums of money requisite to carry out improvements where local means might be wanting, ought to be considered as a national object in this commercial country?—I think the Government should give every assistance possible to the improvement of the ports.

242. Do you not consider that that would be an economical application of the public money?—I am of that opinion, decidedly.

243. Have you been applied to on the part of any persons in France to go over there?—Yes. I have been applied to by the chairman of the Chamber of Commerce at Rouen, to examine the port of Havre-de-Grace, Honfleur, and the river Seine, but more particularly the improvement of the river Seine; and I propose going over there in a few days to examine those ports. I have received a letter from the chairman of the Chamber of Commerce upon the subject.

244. The letter states that at the mouth of the Seine there are banks of sand and other impediments which are injuring the harbour, and he wishes for your advice, with a view to its improvement?—Yes. I will give a copy of that letter and my answer, because it contains the principles upon which I have acted, and on which I think the improvement of tidal rivers and harbours should be conducted. (*Vide Appendix, No.* 4.)

245. (*Capt. Washington.*) With the opinions which you hold very strongly with respect to the improvement of tidal rivers, would you, were the Clyde now placed in your hands, with no impediments to the navigation, place parallel dykes or not?—I would, to a certain extent, place parallel dykes, but dykes differently designed and constructed altogether from those which now exist. I would erect half-tide and quarter-tide dyke-works. I would undo, to a large extent, much of the works which had formerly been done, and I should also change every single department connected with the operations of the river and harbour, and re-organize them upon a different basis.

246. Would not such dykes impede the flow of the tide?—They should be so constructed as not to impede the flow of the tide.

247. (Mr. *Hume.*) But why would you have any dykes at all?—It is necessary in soft soil like the Clyde to protect the banks and guard the channels by dykes or beach-works; it is at the last half ebb that the scouring power takes place generally in the Clyde, and it is then that the water would be confined within the limits of those parallel dykes and act upon the channel, and keep it clean.

248. Then should there be one continual line of half-tide dykes?—I would begin with quarter-tide dykes at the lowest part of the river, near the deep water or sea.

249. The height of those would be equal to a quarter tide?—Yes, and higher up the river I would place half-tide dykes, and in the highest parts dykes as high as high water.

250. In order to benefit by parallel dykes, must not the dykes be continued till you come down to the deep water?—They must.

251. If any interruption takes place in the dykes, will not the part where that interruption takes place be liable to silt up and form banks?—I have found so by experience.

252. You said that one object of making parallel dykes would be the protection of the banks in the upper part of the river; do you think it necessary for the scouring power?—No, not altogether necessary for the scouring power, but to prevent the banks of the river from being washed away. Wherever the dykes break down, the waves of the river wash out the alluvial stuff from the banks into the bed of the river and form banks and shoals.

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253. You would think it essential that the banks should not diminish the reservoir?—Most certainly.

254. (*Capt. Washington.*) You have stated that you think if all impediments were removed the greater power of the tidal water would keep Glasgow Harbour much deeper than it is at present; do you consider the depth of the water in the harbour due to the tidal waters or to the river freshes?—To neither one nor the other but to the dredging power. Land floods deposit large quantities of sand in the harbour.

255. How great is the rise in freshes in general?—Fifteen feet in the harbour in high floods above low water.

256. What is the greatest rise of the tide?—From 8 feet to 8 feet 6 in the harbour of Glasgow.

257. Is not Glasgow often flooded by great freshes?—Since 1839 I have not known it flooded.

258. Would not the removal of these impediments tend materially to the better drainage of the city of Glasgow?—Most unquestionably.

259. You are of opinion that the waterworks and factories depending upon the supply of water from the Clyde, as at present, can be maintained in other ways so as not to interfere with the removal of the impediments you are speaking of?—I think so.

260. Who has been the consulting engineer during the time you have been resident engineer at Glasgow?—Mr. James Walker. He made out the late Parliamentary plans.

261. Have your different proposals for the improvement of the river been submitted to him?—No, not the building of any quay-walls or works; but the Parliamentary plan of Mr. Walker, which is now on the table when it was passed, was found to be of so large and expensive a character, that I was directed by the Committee of Management to draw out a plan for the improvement of the river Clyde less expensive, which was approved of by the general trustees in July, 1841, which plan has been nearly the basis on which they have made their cuttings since, and those proposed.

262. Did not that plan embody the principles contained in Mr. Walker's plan?—It did.

263. Was that plan, so modified, submitted to Mr. Walker?—I do not think it was ever submitted to Mr. Walker to my knowledge.

264. (Mr. *Hume*.) Have you had occasion to consult him since upon any of your proceedings?—No. All the works which I have executed the plans have been drawn by myself, and executed by myself, without consulting any engineer whatever during the six years.

265. Then, from the time that you received your instructions, Mr. Walker has not been consulted by the authorities?—Mr. Walker was consulted; but not on the building of the quay walls, the timber wharfs, or the construction of Bowling Basin; the bridges are under the management of the trustees for building the Glasgow bridges. And he has been, I believe, consulted about laying rails on the quays of the harbour by the Clyde trustees.

266. Why are they obliged to take down Stockwell Bridge?—It has been alleged to be insecure.

267. Owing to what cause?—They have alleged that the deepening of the upper harbour endangered Stockwell bridge. But I deny that. None of the operations conducted under my superintendence have at all rendered Stockwell Bridge insecure, as it has been properly protected since by new works.

268. Do you propose any further operations that would endanger Stockwell Bridge?—I do not think that any deepening that may be required for the small craft would now endanger Stockwell Bridge. Mr. Walker has lately driven a close row of piles, immediately below the bridge, and also four rows of open piles, and above the bridge he has driven another row of close piles, so that the foundation of Stockwell Bridge has been completely shut in and protected;, and I do think that Stockwell Bridge is perfectly secure at present.

269. Do you know any reason why the Clyde Navigation out of its funds should give any money towards that bridge?—I know of no reason except, for additional tidal water, the one alleged. By the removal of the weir to a point 140 yards above Hutchison's Bridge.

270. Would that be any injury, in your opinion, to the foundation of Stockwell Bridge?—None whatever, if a new bridge were built; but it would be a benefit to the harbour so far that there would be an additional flow of the tidal water up that length; but at the same time it would be attempting to legalize what I consider a very unlawful thing, namely, putting a weir across a tidal river, which I object to most decidedly as being highly injurious to the navigation.

271. Was that weir put across under any legal sanction?—No; but the Clyde trustees were bound by Act of Parliament to secure the bridge and the level of the water at Stockwell Bridge, when the old weir at Glasgow Bridge would be removed.

272. Therefore, as it was placed there without any legal sanction, it may be removed under the authority which exists for removing all impediments in navigable rivers?—I think so if a new bridge be built. The weirs upon the Shannon river in Ireland I think were removed where required.

273. And you consider that any appropriation of the funds of the Clyde to the erection of bridges is not warranted?—I think not, nor for any additional tidal water which might be obtained by deepening and improving the channel bed of the river Clyde.

274. The weir across was not erected by any public authority?—No; the original weir that existed at Glasgow Bridge was erected in consequence of the old bridge being in a state of danger from floods. On a Sunday they threw in an immense quantity of stones, it was in such imminent danger, and those stones remained there to support the foundation of Old Glasgow Bridge.

275. In what year was that?—I cannot say; it was before my time.

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275*. Then that weir existed till the New Glasgow Bridge was built?—Yes; but the weir was removed after the Clyde trustees got their last Act of Parliament up to Stockwell; previously to that there was no regular weir at Stockwell; there were stones across, to guard its foundation against the action of the floods; and when a new bridge has been proposed at Stockwell, it has been proposed to remove the weir 140 yards above Hutchison's Bridge.

276. *(Capt. Beaufort.)* With regard to the supply of the factories in Glasgow, if the water was taken from a higher part of the river, would there be any necessity for a weir at all?—There would not. It would be quite practicable to get water from a higher part of the Clyde by an open cut, and by that means they would get clear water.

277. Can you say how far they would have to go up the river?—About two miles and a-half.

278. By that means the navigation of the river would be clear for two miles and a-half up?—It would be cleared for nearly three miles up; it would produce a great increase of small shipping craft, the river would also become a valuable conveyance for coal and iron, from the higher country to the ships in the harbour of Glasgow, and small steamers might sail up from Glasgow Harbour to the town of Rutherglen, and downwards.

[*The Witness withdrew.*]

Adjourned till Friday at one o'clock.

Friday, 2nd May, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Mr. Hume, M.P.	Capt. Beaufort, R.N.
Mr. A. Chapman, M.P.	Capt. Washington, R.N.
Mr. Godson, M.P.	

Alan Stevenson, Esq., examined.

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280. (Mr. *Hume.*) You are engineer to the Northern Lights?—I am.

281. How long have you been acting as civil engineer?—Since 1829, more or less.

282. Have you directed your attention to tidal harbours and rivers?—I have.

283. Will you state what rivers you have viewed?—I have been connected with the Tay and the Forth in Scotland, and with the Ribble and the Lune in Lancashire, and the Dee in Cheshire.

284. Have you been employed professionally to view and to give opinions on the state of those rivers?—I have. I have acted along with my brother, and along with my father.

285. Have you found in all those rivers a disposition to silt up?—Yes; there has in most of them been a considerable fall in the bed of the river, which I attribute to the tendency to silt. I mean that the upper part has been shallower than the lower part; the fall in the bed has been greater than one would expect.

River Tay.

286. With regard to the Tay, will you state what have been the results of your observations there, as to encroachments on the navigation, and the measures that have been adopted to remove those encroachments?—I surveyed the Tay, in 1833, along with my brother, David Stevenson, engineer in Edinburgh, and at that time the principal obstructions to the navigations were at Kirwhinnel Ford at the top of Mugdrum Island, at the entrance of the River Earn, at Seggieden Ford, at Mill Hurst, and at several other fords.

287. What was the nature of those obstructions?—Most of the obstructions consisted of a hard band of gravel lying across the river, but it occurred at each of the islands in the river, and the channel was diverted into a double course opposite those islands immediately at the fords.

288. Those had been probably ancient fords before bridges were established?—Very probably they might. We found nothing, however, except some timber at Millhurst, to induce us to imagine that they were artificial.

289. Were there any other impediments on the side of the river?—Yes, down at Newburgh in particular.

290. In many places?—There were some 8 or 10 jetties thrown out.

291. To what extent were any of those jetties?—Some of them reached so far as to come into a depth of 8 or 10 feet at high water, and 200 feet within the tide mark.

292. How many feet was the longest?—On the opposite side of the river they were very long; about 200 feet was the length of Lord Dundas's longest jetty.

293. Forming a bank into the stream of 200 feet?—Yes.

294. Was it made throughout the whole of those 200 feet solid?—Solid throughout, of stone.

295. What was the immediate effect of that solid projection on the depth of the water of the river?—The effect was to produce a very large accumulation of gravel and mud chiefly on the upper side of the jetty.

296. Do you consider that that collection was formed by the impediment which the jetty gave to the free flux and reflux of the tide?—There can be no doubt of it, because in the case in which I was examined, in Perth, before the Jury Court, three years ago, for the purpose of removing those jetties—I mean the case of the magistrates of Perth against the Earl of Zetland—evidence was adduced to prove that where the jetties now are the navigable channel of the river existed before those jetties were erected.

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297. What was the result of that trial?—The result of the trial was an order to remove the jetties in part only. We were obliged to content ourselves with the removal of only part. We could not get the whole removed.

298. How long had those jetties been established?—Some of them 20 years, and some of them came very nearly within the time of prescription, which is 40 years, but the great majority of them were not so old.

299. Did you submit to the Court the propriety of removing the whole of the jetties that were within high water mark?—Not to the Court, we were obliged to content ourselves with requiring less of the Court, in obedience to the opinion of the law adviser.

300. But in your opinion the navigation of the river would have been benefited by removing them entirely?—Yes.

301. Did your evidence go to that?—My evidence was confined solely to the question that was before the Court.

302. Has any portion of those jetties been removed?—Part has.

303. Have you had any opportunity of knowing what has been the effect consequent upon that removal?—There has not been sufficient time to see the effect of the removal yet, because the artificial fore-shore which they had created still exists; it has not been removed.

304. Therefore the collection formed by those jetties will require some time or artificial means to remove it?—In all probability artificial means.

305. In what other parts have you found encroachments?—Opposite the Earl of Wemys's property, at a place called Muirhead, a large jetty was extended; it went out, I think, 600 feet.

306. (*Capt. Washington.*) To low-water mark?—Yes; I am speaking from recollection of the length of it.

307. (Mr. *Hume.*) There appears to be an embankment extending from the river Earn, westward, do you allude to that?—No, the embankment does not exist now; it was removed upon a report being made. The Earl of Wemys acknowledged that he was bound to remove it; we required him to remove it, but it had begun to cause accumulation.

308. That jetty at Wemys has then been removed?—It has.

309. Is the embankment and accumulation of mud which was forming decreasing now?—Yes it did decrease, and it was partly helped by dredging.

310. At what other places have jetties been made?—Several applications have been made since 1834, when the last Act for the improvement of the Tay came into force for leave to extend some of the existing jetties; but in all cases they have been refused, from the conviction that they tend to retard the progress of the tide upwards.

311. Opposite the property of David Hay, Esq., Newburgh, there appears to be stone dykes near Mugdrum Island, have you visited that?—Yes, I have.

312. State the nature of them, and by whom erected?—They were erected partly by Mr. Hay, partly by Sir John Richardson, and partly by John Lee Allen, Esq.

313. How long have they been erected?—Some of them a good many years.

314. Has any application been made to remove them?—No.

315. What is the effect of their remaining?—Their effect is to form land, and to decrease the tidal space of the river.

316. Who are the conservators of the river from Perth downwards?—The city of Perth.

317. To what point?—To Invergowrie Burn; it is three or four miles above Dundee.

318. (*Capt. Beaufort.*) When you ordered all these piers to be removed, did you propose any other means by which the inhabitants might obtain a connexion with the river, any substitute for the pier?—Those were jetties for forming land, and not piers; between every one of them a crop of reeds was planted.

319 They were to act in order to make land?—Yes, that was the professed object.

320. (Mr. *Hume.*) Are the Commissioners to understand you to say that those dykes were formed, and that on each side reeds were planted with the view of forming land in the middle of the river?—Yes.

321. Has that been done to any extent in the neighbourhood of Mugdrum Island, or any other part of the river?—It has been done in various parts of the river.

322. Are the Commissioners to understand that land has been acquired by that means from the natural stream?—Not what we can call the natural stream, but in a part of the river which was daily covered by the tide.

323. Will you state one or two more of the encroachments?—At Nethermains Island in particular, opposite Mugdrum Island. I have myself observed the process of land making there on my visits occasionally to the river. I have seen the changes going forward to a considerable extent. It is very different now from what it was when the survey was first made; there is a much larger fore-shore in front of the island.

324. To what length does the dyke extending from Nethermains Island to the south proceed?—The dyke is very nearly 1000 feet long, I think, now; in fact, the dykes there are nearly meeting.

325. Do you mean to say that the dykes at the north side of Nethermains Island are nearly meeting the dykes at the south of Mugdrum Island?—Yes; in one case they are not very far from it, a few hundred feet.

326. Is not the effect of that to narrow and impede the flow of the river upwards?—Unquestionably it is.

327. Has there been any embankment formed on the north side, west of Nethermains Island?—There has.

328. Have you visited that?—I have.

329. Is that converted into land?—It is.

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330. Have you visited a pier projecting from the lodge of Sir John Richardson's estate on the north side of the river to the cairn of stones?—Yes.

331. (*Capt. Washington.*) Were those dykes of which you are speaking erected by the permission of the trustees, opposite Sir John Richardson's, for instance?—Sir John Richardson's pier of Cairnie was by order of the Commissioners of the Tay navigation shortened, according to our recommendation, so as to avoid interfering with the stream; but there was to a certain extent liberty given to erect a low mound of gravel along the fore-shore, partly for the purpose of directing the currents into the south channel, and partly in order to compensate for the damage done to Sir John Richardson's fishings, for which the Harbour Commission were liable, and in obviating which it was desirable to meet, as far as was consistent with the interest of the navigation, the views of the tenants of the fishings.

332. (Mr. *Hume*) Are we to understand that the conservators of the river of the city of Perth gave their sanction to Sir John Richardson for the projection of that pier?—They gave him their sanction to deposit the materials they were dredging on the opposite side of the river at the fishing cairns, and the dredged material was laid along the fore-shore, opposite Sir John Richardson's property.

333. Have those cairns, which appear on the map in the middle of the stream, been removed?—They have.

334 What has become of the materials?—A great part of the materials were deposited opposite Sir John Richardson's grounds, which was also found a very convenient and suitable place.

335. Extending into the river?—No, extending chiefly along the inner bank; part, however, were deposited immediately below the pier which had been shortened in the line of the channel.

336. What has been the effect of that deposit of the materials there? Has it caused an accumulation?—The effect has been to throw the stream towards the south side.

337. The effect has been to impede, as far as it projects, viz., 500 feet into the stream, the flow of the tide?—To impede to a certain extent the flow of the tide there; but it also has the effect, we conceive, of deepening the channel at Kirwhinnel. The dyke of 500 feet long was not recently formed.

338. But while it deepens the channel at Kirwhinnel, does it not stop the flow to Perth?—To a certain extent it must, of course.

339. If there are a great many of those small impediments, such as you have spoken of, on each bank, do they not on the whole impede the flow considerably?—The aggregate effect of a very great number would be injurious.

340. Without entering into the details of all the encroachments, can you state what the depth of water was a few years ago, and what the depth now is, since some of those impediments have been removed?—Before the operations began in 1834, the depth of the river at Mill Hurst Ford, which is 3 miles below Perth, at high-water of spring tides, was 11 feet 9 inches, and at low-water it was very nearly dry, there being only 21 inches water.

341. What was the rise of the tide at that time at Perth?—The rise of the tide at Perth at that time was about 8 feet.

342. Did the Commissioners at Perth obtain an Act of Parliament to enable them to deepen the river downwards, and when?—They did in 1834.

343. Have those deposits been made opposite Sir John Richardson's land since the passing of that Act?—Yes, that was done subsequently to the Act; but not the formation of the dyke, which is older.

344. Did the Act direct them to deepen the river throughout from Perth downwards?—It directed them to deepen the river from Perth down to Newburgh, not lower; their operations do not extend below Newburgh.

345. But they removed the fishing cairns from the middle of the stream; and the deposit on the property of Sir John Richardson is within the space between Perth and Newburgh?—It is.

346. Then was not that a contravention of the Act?—No, because the dredged material must be deposited somewhere, and as close to the margin as possible is the place where it is least injurious.

347. Is it your opinion that all materials dredged from the bed of the river should be laid out on dry land, so as not to interfere with the flow of the tide?—I should say that it depends upon circumstances; the expense of doing so might be very great.

348. I am not alluding to the expense, but would not the doing that tend to improve the river, by keeping the flood and ebb clearer?—No; there are circumstances in which it might be advantageous to deposit materials within a tide-covered space, as at the Islands of Balbepburn, Sleepless, and Darry; I conceive that it was advisable to fill up the back lakes there.

349. Does not the filling up, in a degree, tend to retard the flow of the tide?—No, not particularly.

350. Will it not prevent it from flowing to the upper part to Perth?—No, for the space obstructed is compensated for by cutting and by deepening opposite; it would rather have the effect of quickening the tide, by giving it a better direction.

351. Then the opinion you have given of the propriety of filling up any portion, is on the assumption that you are to make a corresponding increase of depth in another quarter?—Yes, generally so; perhaps I might explain a little with regard to that. As a general principle it is not at all desirable to exclude any quantity of the tidal waters; but there may be particular cases in which to gain an object, in straightening the channel and giving it a better direction, you might exclude a very little of the tidal water without any disadvantage to the navigation.

352. That is wherever you can by that operation straighten the direction of the current you would give a greater impetus, and by means of that greater impetus counteract the greater impediment which would arise?—Quite so; for example, I conceive the straightening of the

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current at the Earn, and the removal of the fishing cairns there, to have quickened the tide. I know it to have done so.

353. Who has superintended those excavations and clearances in the Tay?—My father, my brother, or myself have always done so.

354. Then you are able of your own knowledge to speak to those facts?—Yes.

355. You have stated what the rise of high water at Perth in 1834 was; since the removal of those impediments what has been the rise of high water there?—The tide now reaches Perth about 55 minutes sooner than it did before those operations.

356. How much higher does it rise?—It does not rise much higher, I think hardly at all, but there is deeper water—the channel is deepened.

357. At Mill Hurst ford, where there were, in 1834, 11 feet 9 inches of water at highest spring tides, and it was nearly dry at ebb, what is the depth of water now?—It is about 4 feet 9 at present at low water, and at high water it is nearly 16 feet.

358. That is, you have 4 feet 9 where it was nearly dry, and 16 feet where it was a little more than 11?—Yes.

359. Is that depth of the channel carried all the way from Perth downwards, or do you allude only to one particular part?—In some places the channel has not been deepened at all; that is, it did not require to be deepened; it was naturally of a proper depth.

360. Is the shallowest part of the river 16 feet at high water?—Fifteen feet; the tide now does not rise to a much higher level than it did in 1834, but there is an increased depth of water.

361. By what means has that increased depth of water been gained?—It has been gained chiefly by the removal of the fords, which acted like steps against which the tide in its upward progress impinged, and waited some time till it had risen to the top and then made a sort of jerk and so got into the next space; those impediments have now been removed, and the tide flows with a more equable velocity throughout the whole space than it did before.

362. Has the removal of those projecting dykes and encroachments assisted to increase the flow and also the scour?—None of those dykes have been removed under the operations except those at the Earl of Zetland's property, the effect of the removal of which has not yet been seen.

363. Have you made any report to the magistrates of Perth of what the depth of the water might be, if all the impediments that you can point out in the navigation were removed?—I reported to them, that, by dredging to perhaps the same extent as we have done, and removing 800,000 or 900,000 tons of materials from the bed it might be possible to get a depth of nearly 20 feet up to Perth.

364. Do you mean that by removing the cairns of stones that have been placed or merely the fords?—Deepening the fords and shallows chiefly; there are not many more obstructions in the shape of cairns, they have been removed; but still it is a constant warfare with the proprietors; they are constantly trying to project fishing stations from the banks.

365. Are any of the proprietors Commissioners under the Act?—Several of them are.

366. Does that in any way interfere with the engineers proceeding to remove those obstacles?—No, I cannot say that I have had any difficulty, from the interference of individual Commissioners.

367. Have you found a disposition to encroach on each side of the bank?—Yes.

368. Do you consider looking to the manner in which this river and other rivers that you know are managed, that a superior authority to the local management ought to exist anywhere if the navigation is to be made as perfect as it is capable of being made?—I think it would be very beneficial to have some final authority to whom an appeal could be made as to whether any proposed change was injurious or otherwise.

369. Do you mean that there should be an independent authority who should be appealed to on every encroachment or interference with the navigation of rivers?—Yes.

370. Do the observations you have made now with regard to the Tay apply to your experience of the Lune and Ribble?—They do.

371. Do you find the same tendency on the part of the proprietors of land on the sides of the rivers to encroach on the navigation at those places?—There is a very general desire to form land on the shores by jetties.

372. The formation of that land on the banks must tend in every instance to exclude the tide must it not?—Yes.

373. And consequently, by degrees, to impair the navigation?—Yes.

374. What is the effect of allowing piers and encroachments at different points to be made; are not banks likely to be formed by the tide taking a set from those encroachments?—In general deep hollows are formed in one place and large banks adjoining; and the navigable current receives a twist opposite each jetty.

375. (*Chairman.*) It produces a sort of eddy?—Yes.

376. (Mr. *Hume.*) And those banks, formed by those projections and jetties, become the principal impediment to the navigation?—They do; they twist the river round instead of allowing it to take a straight course; they produce sharp turnings and retard the currents both up and down.

377. From your experience, do you consider that the Admiralty, or some competent authority, ought always to have a superintendence over navigable rivers and harbours?—I think it would be most desirable.

378. (Mr. *Godson.*) Do not you think that it is absolutely necessary?—Yes, I do; because attempts are sometimes made even to destroy navigations.

379. (Mr. *Hume.*) Are not the interests of those local Boards and local Commissioners sometimes at variance with the public interests in that respect?—Sometimes they are, unquestionably.

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380. The proprietors of the banks desiring to gain land by encroaching on the navigation?—It is chiefly the proprietors of the neighbouring land who are interested in gaining the soil.

381. But are not the proprietors often Commissioners of the local Boards?—Sometimes they are.

382. Would you recommend the appointment of independent Commissioners, that is, Commissioners whose local interests are not affected?—Yes.

383. What kind of check or control do you, as an engineer, think would be best, in order to protect and improve the navigation?—The submission of all plans proposing any changes on the sides of rivers to some public Board, would seem to me to be a great check,—in fact, to require the approval of a public Board before any change could be brought about.

384. Are the Commissioners to understand you to mean that all encroachments formed within high-water mark, in every navigable river, should be submitted to that authority?—Yes, I think so.

385. (Mr. *Godson*) For that purpose you would require a public officer to report when there were encroachments going on?—That would be necessary, undoubtedly.

386. (Mr. *Hume.*) My question to you as to a check had allusion to the existence of a permanent superior authority, having the conservancy of all rivers; is that what you would recommend?—Yes, because those encroachments are often made in a very short time; in a few days a serious encroachment is made, without any previous notice.

387. Would you consider it necessary to have a superintendent of every creek and river, and a map lodged with that competent authority, that he might be able to check any encroachment?—I think they could not act without local officers and correct plans for reference.

388. (Mr. *Godson.*) Could not some person belonging to the Customs have such a charge of the river as to be continually reporting the beginnings of encroachments?—I think there might be such a person.

389. (Mr. *Hume.*) Have you any further observations to make on the state of the navigation, and the velocity of the tide in the Tay, before and since your operations?—Previous to the commencement of our operations in 1834, the velocity of the tidal wave at Dundee and Newburgh, (the distance between them being 22 miles,) was exactly the same—there is no difference there—no operations have taken place below Newburgh.

390. (Mr. *A. Chapman.*) But may not it be the case, that by embankments being properly placed, the velocity of the tide may be increased, so as to give additional scouring power to the river?—Yes; if embankments are properly placed. We have placed three embankments with that special object in view. The great object I conceive to be to remove every kind of obstacle to the natural flow of the tide upwards, whatever it be, whether it be a sudden change of level in the bed of the river, or the projection of artificial works, such as jetties from the side, or very sharp turns in the course of the river.

391. (Mr. *Hume.*) Do you give that answer referring to the principle to which you before referred, that for all encroachments on either side compensation in excavation should in some way be given?—I do generally; but I do not go the length of saying that the principle of shutting out as small a portion of the tidal water as possible is so very important that it may not be departed from for some better reason.

392. Do you not admit that the principle of shutting out as small a portion of the tidal water as possible, is the rule upon which you should act, but that there may be some instances where a compensating advantage by filling up or giving a better direction to the stream may be derived?—Yes, I will suppose a case of this kind. Where you have a river coming into a flat channel and moving about tortuously in every direction, I think it might be a legitimate improvement to form a stone wall to guide that river, (as was done at the Ribble) in its course through the sand; that wall might abstract a very small quantity of the tidal water which would be in proportion to its mere displacement and it might not be compensated for, as there might be no means of compensating for it, yet I think the loss of water would in general be very unimportant.

393. Do you consider the particular height of that wall to be important—whether it should be quarter, half, or full-tide high?—It would depend very much on the situation, but generally I should wish to keep that wall very low, rather to make it as a guiding point for the entrance of the flood, and for the recedence of the ebb—the last quarter of the ebb.

394. (*Capt. Washington.*) And that is the most important part of the tide?—The entrance of the flood is a very important agent in stirring the bed.

395. (Mr. *Hume.*) Will you proceed in describing your farther operations?—The operations have taken place, as I said before, chiefly at those fords above Newburgh, between that and Perth. From Newburgh to Perth the velocity of the tidal wave, previously to those operations, was at the rate of 3·42 miles an hour. Now that velocity is very different. From Newburgh to Carpow it is 3·17 miles an hour, from Carpow to Kinfauns it is 5·36, and from Kinfauns to Perth 6·93. The mean velocity for the propagation of the tidal wave between Newburgh and Perth is now at the rate of 5·13 miles an hour, instead of 3·42 as formerly.

396. Do you consider that to have arisen from the removal of the impediments you have spoken of?—There can be no doubt of it.

397. Have you any other observation to make respecting the Tay?—No, I have nothing more to add but what I give in detail in this Report, (*delivering in his Report on the Tay.*)

398. (*Capt. Washington.*) Will you state the relative velocity of the tidal current in 1833 and the present time?—I have made no observations on that.

399. (*Capt. Beaufort.*) Have any alterations taken place at the mouth of the Tay which may have affected your tidal wave?—There have been changes at the mouth of the Tay which I do not know the extent of. I have not had an opportunity of examining them, nor

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do I know whether they are independent of our operations, or whether they are in consequence of them.

400. (Mr. *Hume.*) Who has charge of the mouth of the Tay?—The Trinity House, or Seamen's Fraternity of Dundee, have charge of the lights and buoys.

401. Do you know what engineering officer is employed under them?—They employ us about their lighthouses.

402. (*Capt. Beaufort.*) The banks of both points at the mouth of the Tay have altered their shape?—They have. I have not been employed, but I am informed that a survey has been taken by order of the Admiralty, and from that the Commissioners will get the necessary information upon the subject. (*See Report on the Tay, by the Admiralty Surveyor, in Appendix.*)

403. (*Capt. Washington.*) Does not the Tay drain the largest extent of country of any river in Great Britain?—It drains a very large extent of country, 2283 square miles.

404. Can you tell us the quantity of fresh water brought down by the Tay?—It brings down 273,000 cubic feet in a minute.

405. Is that the mean discharge of the Tay?—It is.

406. All the year?—Yes.

407. That is including the Earn?—Yes, it is the Tay and Earn together; the Tay itself discharges about 220,000 cubic feet.

408. Can you state at all the relative proportion between the fresh water brought down by the river and the tidal water carried up by the flood?—No, I cannot.

409. You state that the Tay drains 2283 square miles; from what do you take that?—I take it from Arrowsmith's map; and the discharge of the Tay I take from the measurement by Professor Anderson, of St. Andrew's; and the discharge of the Earn is from a measurement of our own; it discharges 54,959 cubic feet a minute.

410. (Mr. *Hume.*) What proportion does the discharge you have given of the Tay bear to the discharge of the Thames?—Mr. Rennie states the Thames at 80,000 cubic feet a minute, measured at Teddington weir, to which the tide rises.

411. (*Capt. Washington.*) What quantity of soil has been dredged up from the Tay, under your direction?—The whole quantity, since the operations began, is 841,480 tons.

412. Where do you deposit the soil dredged up?—A great part has been deposited at the back of Sleepless Island, at the back of Millhurst, and at the back of Balhepburn Island.

413. (*Capt. Beaufort.*) In the way of the channel?—No; it was formerly a back channel; it is now shut up by the three embankments.

414. (Mr. *Hume.*) Do you not consider that that has in some measure impeded the flow of the tide upwards?—No, I conceive not. The fact of the existence of this back channel, in connexion with the shallow part of the river at the top of the island, proves to me,—(I will not say) that the ford was the cause of this channel; but, at all events, they were connected together as cause and effect; and, undoubtedly, the removal of the ford, and the shutting up of that channel, has greatly improved the principal channel.

415. Do you think that the improvements in the main channel, and the removal of the ford, was a sufficient compensation for that which you filled up behind the islands?—No, I think not; and we found it not to be the case till we cut away the principal part of the fore-shore, particularly at Sleepless, and also at Balhepburn and Millhurst fords.

416. Do you consider that you gave compensation in space for what you were filling up behind the islands?—I think fully; and I think the rapid propagation of the tide-wave through it fairly shows it.

417. (*Capt. Washington.*) How high above Perth does the tide make itself felt?—It goes two miles and a-half above Perth.

418. About what distance from the sea?—About 35 miles.

419. (Mr. *Hume.*) Has the tide extended its range no further than that?—No, I have not observed it; but I do not know that it could, because there is an obstruction in the bed of the river at the bridge of Almond.

420. (*Capt. Beaufort.*) Does the salt water go up to that point?—No, it is only up to that point that the tide is felt.

421. (*Capt. Washington.*) How high does the salt water go?—Judging from the marine productions, a very little above Mugdrum Island.

422. (*Capt. Beaufort.*) Is the water salt at Perth?—No.

423. (Mr. *Hume.*) How far is Mugdrum below Perth?—It is about 25 miles from the mouth of the river, and seven miles and a half below Perth.

424. And the tide flows up 10 miles more?—Yes.

425. (*Capt. Washington.*) Are you at all acquainted with the Tay below Newburgh?—I have very often sailed up and down it. I should not say that I know it minutely as an engineer below Flisk Point.

426. Have you seen the jetties thrown out by Lord Kinnaird and Mr. Allen of Errol on the north side of the river?—Yes, I have.

427. Do you not consider that they will be very detrimental, if completed, to the navigation of the river?—I think they will shut out a very large portion of the tidal space of the river.

428. Looking at the plan showing the jetties thrown out by Lord Kinnaird and Mr. Allen, what area of tidal water will they exclude?—Roughly, I should say two square miles and a-half of surface (nautical miles), or about 1800 acres.

429. What proportion, in your opinion, will that bear to the whole estuary?—I cannot state the proportion; but it is a very large proportion.

430. To what extent are the jetties thrown out across the river?—The longest is about half a mile.

431. (Mr. *Hume.*) Will not every such encroachment on the banks counteract the benefit

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which you have shown to arise from dredging and removing the difficulties which oppose the improvement of the river?—I am afraid I could hardly answer so absolute a question as that, because there might be an encroachment for any important purpose, putting in a weir, for example, which would be still an encroachment, and yet the quantity of tidal water obstructed by it might be so small as to be of no practical importance.

432. Supposing those encroachments to be for the purpose of gaining arable land from the river, what would be the effect?—The effect would depend upon the depth of the water in the area to be enclosed. I may observe, in regard to that question, that there are so many circumstances in each particular case, that it is hardly possible to give a general answer, further than to state that any obstruction of the tidal waters is disadvantageous, inasmuch as it affects the scour; but I can conceive a river to be too wide at a certain place.

433. Not as regards the bed?—Not if you consider the bed alone; but if the mouth of the river be very narrow, and the space above is excessively large, it is conceivable that it might require the whole time of the flood to fill that space before it could affect the upper part at all, and in this way the beneficial effect of the tide might, in such cases, be circumscribed. Those are extreme cases, and it becomes a difficult thing to answer questions of a general kind.

434. (*Capt. Washington.*) But is not maintaining the width of a large river or estuary of great value, in order to maintain the depth by means of the wash of the sea?—It is.

435. Were you ever consulted on these projections of Lord Kinnaird?—My brother visited them, and reported to Lord Kinnaird unfavourably of the projections, as regarded the navigation.

436. (*Capt Beaufort.*) What is your opinion of the effect that would have taken place if Government had permitted the bridge at Mugdrum to be made for the railway?—I think it would have destroyed the navigation of the Tay upwards entirely.

437. (Mr. *Hume.*) Were you consulted upon it?—I was employed to report upon it by the Tay Navigation Commissioners.

438. Did you give an opinion as to what the effect of the passing of the railway would be?—Yes, I gave an opinion that it would be prejudicial to that navigation.

439. Did you give a written report?—Yes; it is printed, and I beg to lay it on the table.

440. (*Capt. Beaufort.*) What is the lowest part of the river which you think a bridge might with impunity be thrown across?—I think certainly not lower than the town of Perth, if so low.

441. Do you apprehend any mischief from the proposed railway bridge across the river Earn?—No, I think the evil would not be so great there.

442. (Mr. *Hume.*) Is the Earn navigable?—For small barges.

443. Do they propose to throw a bridge over the part that is navigable?—Yes, but it is a swing bridge.

River Ribble.

444. Have you and your brother been employed to report on the navigation of the river Ribble, which runs up to Preston?—We have. (*The Witness produced a map of the River Ribble.*)

445. What was the nature of your examination and report?—The report recommended the deepening of the upper part of the river, by removing a large band of solid rock which ran across the river, and dredging in various parts of it, and also removing a number of jetties, which were laid down for the purpose of forming land, and which tended to twist the river, and to throw it into deep holes. This plan shows the former state of the river. (*Witness exhibited a plan.*)

446. In what year did you begin your operations there?—In 1838.

447. What was the depth of the water, then, up to Preston?—I do not remember the exact depths, but I think between five and six feet depth of water has been obtained in the river, by the operations in the lower part, where the dredging was. The excavation of stone in the upper part will admit of deepening all the way to Preston to 20 feet deep.

448. To what extent has the dredging been carried?—The dredging has been carried between the town of Preston down towards Clifton Bank. A wall has been formed for the purpose of directing the current towards the Nase Point, at Freckleton.

449. What is the depth of water now maintained at Preston?—Up to Preston Marsh I think there are 14 feet. But it is some years since I visited Preston. My brother has the chief charge of that work.

450. Has the effect of removing those jetties and dredging been to increase the depth of water?—It has.

451. Were you able to see whether any encroachment of land has been made on either side of the river, formerly covered by the tide?—No; the effect of the jetties was rather to disturb the channel, and make the bed of the river irregular in respect to its channel—deep in some places and shallow in others; and those jetties have been removed, and the channel made more regular.

452. Are there any other impediments that you contemplate removing, in order to increase the depth of water?—No; the removal of the rock has been completed; about 31,000 cubic yards of rock were excavated by means of cofferdams.

453. Did you act on the same principles, in clearing the Ribble, as those you had laid down, and on which you have acted respecting the Tay?—Yes, the same principles in deepening the upper part and removing anything tending to twist the stream.

454. Did you find the tide came sooner up to Preston than formerly, in consequence of those operations?—There is a change, but I am not acquainted with its extent.

455. Generally speaking, are we to consider that the same results took place from your operations in the Ribble as took place from your operations in the Tay, though not to the same extent?—I do not know that they may not have been to the same extent, but no Report has been made; the result has not been called for in any way.

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456. But, having acted upon the same principles, do you think that it would be advisable to carry them out in any other case?—Yes, they excavated 31,000 cubic yards of rock from the upper part of the river, so as to give a depth of 20 feet at spring tides at that place. This is a great obstruction removed, and it was a work of great difficulty.

457. By that means principally, you consider, in addition to the removal of the jetties, you obtained that increased depth of water?—Yes, and by dredging.

458. Do you contemplate any further operations in the river, in order to increase the depth?—The dredging will be carried on, and the wall completed, in order to direct the current.

459. Is there still any capability of improvement to a great extent?—There is.

460. What depth do you consider may be obtained at Preston?—I have not considered that, but I do not see any limit to it within the depth of the rock cutting.

461. Have you been employed on the Lune?—Yes, *(producing a map of the River Lune.)*

462. Will you state in what condition you found it when you first went, and what operations you have carried on there?—No operations have been carried on. Proposals were made for operations, but the Harbour Commissioners of Lancaster had not the funds to do any work there. We surveyed it, and pointed out the changes that might with advantage be made; but no changes have been made.

463. What is the distance from Lancaster to the sea?—About six miles.

464. Vessels of what draught of water can get up to Lancaster?—The depth of high water would be, if the operations we have recommended were carried out, about 16 feet up to Lancaster.

465. What is the present height?—Less than 13 feet over the ford at spring tides.

466. By what means do you propose to raise it to that depth?—Chiefly by dredging.

467. (Mr. *Godson.*) There is a ford to be removed close to Lancaster, called Scale Ford?—Yes, that is to be removed by dredging.

468. (Mr. *Hume.*) Where are the docks situated belonging to Lancaster?—They are situated at Glasson.

469. What is the depth of water at Glasson?—The depth of water at Glasson is 25 feet 6 inches.

470. Did your report contemplate the deepening of the river up to Lancaster, to that extent?—No, the report only contemplated deepening it to 16 feet at high water.

471. Do you consider it capable of being deepened up to 25 feet 6 inches, the same depth as at the docks?—It would be very difficult to get it to that depth, as the fall on the river's bed is very great. It would be still more difficult to maintain it at that depth, as the fall on the river's bed would be removed.

472. (Mr. *Godson.*) There are two fords that you would have to remove?—Yes; there is Scale Ford, and a ford a little below, called Baffler's Ford.

473. About how much money would it take to remove those two fords, so as to have 16 feet of water up to the quay-side; would it take 10,000*l.*?—No; I should think it would be considerably under 10,000*l.*; but I do not recollect the figures at this moment for these particular portions of the work.

474. Is there any other impediment which you would have to remove of an expensive nature for the purpose of enabling vessels drawing 16 feet to come up to the quay side?—Heaton Shoal.

475. What would you do with that?—I would dredge it, and the same with Colleway Shoal; and I would widen the part opposite Red Bank, and straighten and deepen the channel generally.

476. (Mr. *Hume*) Do you consider all that work possible to be done within the estimate of 10,000*l.*?—No; but I can supply the Commissioners with a copy of the estimate.* The amount for the whole works was somewhat above 13,000*l.*

477. (*Capt. Washington.*) What is the rise of the tide at Lancaster?—It is about 10 feet.

478. What is the rise of the tide at the mouth of the Lune?—At Glasson it is 21 feet.

479. Does the bed of the river rise very much between Glasson and Lancaster?—There are about 11 feet of rise on the low-water line.

480. (Mr. *Hume*) Did you survey it?—I did not; my brother did.

481. (Mr. *Godson.*) Are not the impediments those you have mentioned of the shoals?—Yes.

482. Would there be seven places requiring dredging within those six miles?—Yes.

483. (Mr. *Hume.*) Is it your opinion that those impediments to the flow might be entirely removed?—I see no difficulty in getting 16 feet depth the whole way up.

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* Probable Estimate of the Expense of Improving the Navigation of the River Lune, so as to obtain a depth of 16 feet at high water of ordinary spring tides, up to the quays of Lancaster, by Robert Stevenson and Sons, civil engineers.

Expense of a dredging machine worked by an engine of 12 horses' power, with punts and apparatus		£5,000	0	0
Ten months' work of a dredging machine, at 175*l.* per month		1,750	0	0
		6,750	0	0
Incidents on the above sum of 6,750*l.*, at 10 per cent.		675	0	0
		7,425	0	0
To complete the further improvements of widening and straightening the channel shown in the plan:—				
Three seasons' work of a dredging machine, taken at 1,750*l.* per annum	£5,250			
Incidents, at 10 per cent.	525			
		5,775	0	0
		£13,200	0	0

Edinburgh, Dec. 14, 1838.

ROBERT STEVENSON and SONS.

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484. (Mr. *Godson*.) Have the inhabitants been obliged to have a new quay between Baffler's Ford and Scale Ford?—Yes, they have a quay there.

485. (Mr. *Hume*.) Are you aware whether any portion of the banks of the river has been enclosed for agricultural or other purposes?—No, I do not know that fact.

486. (Mr. *Godson*.) Have not the corporation of Lancaster, by an Act of Parliament, enclosed several hundreds of acres of marsh land upon the banks of the river at Marsh Point?—I am not aware of it. I do not remember to have heard it.

487. (*Capt. Beaufort*.) How many arches are there to the present bridge at Lancaster?—I think five.

488. (Mr. *Hume*.) Do you consider that the principles you have laid down on the improvement of the navigation of the Tay would apply equally to all the improvements of the Lune river?—Yes, I conceive so.

489. Does the report you have made direct the attention of the Commissioners to those principles?—It does. On everything connected with the Lune I would refer to my brother.

490. (Mr. *Godson*.) Looking at this plan, by which the railway proposes to cross the river, supposing the quay were built below the bridge, would such a bridge as you see depicted impede or not impede the navigation?—My impression is that it would not, but I should not like, without deliberate inquiry, to commit myself by giving an opinion as to the effect of a plan by another engineer.

491. (*Capt. Beaufort*.) Would it be necessary to have a drawbridge there?—No, I think not.

[*The Witness withdrew.*]

Adjourned till Wednesday next, at 1 o'clock.

Wednesday, May 7th, 1845.

Present:—

Captain Sir GORDON BREMER, C.B., in the Chair.

Mr. Hume, M.P.	Captain Beaufort, R.N.
Mr. A. Chapman, M.P.	Captain Washington, R.N.
Mr. Godson, M.P.	

Mr. *William Bald*, examined.

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494. (Mr. *Hume*.) Did you report at any time on the extension of the river Clyde navigation upwards, above the city of Glasgow?—Yes; I drew up a report which is dated Glasgow, 31st July, 1839.

495. Did you, in that report, show how the Glasgow Waterworks could be supplied with water, and all weirs and impediments in the river removed, so that the tidal flow might be increased to great advantage, and the navigation thereby improved?—Yes.

496. Did you point out in what way that might be done?—The report states: "The principal objection offered to the removal of the weir at the Glasgow New Bridge has been made by the Glasgow Water Company. They state, that it would lower the level of their present supply. Now, looking at the Glasgow Water-works, and the numerous public interests connected with them, both industrial and manufacturing; looking at the immense steam-power employed in the water-works, amounting to no less, when completed, than 682 horse-power; and, again, at the vast capital which has been invested in those works, it really, on public grounds, becomes a question of the greatest importance in deepening the river Clyde, and improving and enlarging the port of the city of Glasgow, to preserve these water-works from sustaining any injury, either in lowering the existing level of the water in the Clyde or deteriorating the quality of the water which affords the supply. On this most important subject we fortunately have on record the evidence of the late Mr. Thomas Telford, and we have also the very clear and very able evidence of Mr. James Jardine, engineer to the Edinburgh Water-works: both of these gentlemen mention distinctly, that, if the bottom of the ford at Dalmarnock Bridge be secured, so that its present level remain undisturbed, the weir may be taken away at the Glasgow Bridge, and the Clyde deepened between Dalmarnock Ford and that bridge for about six feet, without, in their opinion, doing any injury to the Glasgow Water-works. But be it understood, that the work which they recommended was not to rise above the level of the present bed of the Clyde at Dalmarnock; for Mr. Telford says, in his evidence, that when the bed of the river would be secured 'a stranger would be unconscious of any such operation having been performed there,' because no weir would he seen traversing the Clyde. Numerous interests would, I fear, offer many serious objections to the erection of a weir rising even a few inches above the bed of the Clyde at Dalmarnock Ford. Attentively reflecting on the evidence of Mr. Telford and Mr. Jardine regarding the Glasgow Water-works, and considering that the ford of Dalmarnock is at present nearly 18 inches above the level of the Clyde, where the present supply is taken for the Cranstonhill Water-works, I think it possible to obtain a supply of water from the level of the river at Dalmarnock without raising its level by the construction of any weirs rising above the present bed of the Clyde at that point, by simply securing the existing level of the river waters at the ford; for I frankly avow that I am decidedly opposed to the erection of any weirs across the bed of the Clyde. It would, perhaps, even be much better to carry a sufficient quantity of water from a still higher level of the Clyde to supply the water-works, than in any manner to interfere with the river channel by the erec-

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tion of engineering works which would obstruct the free passage of the land and tide waters, and prevent the navigation from being improved hereafter in the higher reaches; and also to enlarge and extend those natural tidal flows or scouring powers which would act so beneficially, not only in cleansing all deposition caused by the city sewers, but would also be of great benefit to the harbour in keeping it clear, as well as the whole channel-bed of the river downwards. I am unable to find language to express all my thoughts on the great value which I attach to this upper scouring power, and on the necessity which exists that no part of the bed of the river shall ever be encumbered either with weirs, dykes, or locks where it may be possible for the tidal rise to reach, or to which it at present extends. Looking at the triumphant success with which the open tidal estuaries of rivers have been navigated since the application of steam-power to maritime purposes; looking at the improvements which are being made in so many rivers, not only in Great Britain and Ireland, but also on the new and the old continents, to facilitate and extend the progress of this power into the most remote corners where the tide flows, and the extension of this power which so peculiarly characterizes and adorns the Clyde—the cradle of steam navigation—its further extension into the highest tidal reaches of the Clyde at once claims and demands the deepest attention of those entrusted with the direction and improvement of the river and the port of this great city. Reflecting on the events of the last 25 years in the improvement of the lower Clyde, who can tell to what an extent the improvement of the upper reaches of the river may not be carried?"

497. If that weir was removed, as you suggest, and the water taken above Dalmarnock, would that, in your opinion, give free navigation from Glasgow upwards to that spot?—Quite so.

498. Have any measures been taken to carry out that recommendation of your report?—None.

499. Have you in any other reports addressed to the Clyde trustees shown the great value it would be to the navigation to increase the tidal flow up to the highest part of the river?—Yes; 23rd of September, 1844.

500. What is the nature of that report?—The nature of that report is to show the great injury that the navigation would sustain by filling up even any of the tributary streams connected with the river Clyde where the tidal flow reaches.

501. Have any of the tributary streams to which the tide flows in the Clyde been shut up or the flow impeded?—Yes; a vast quantity of peat or moss has been thrown into the Black Cart River and the River Gryfe.

502. What has been the effect of that peat and moss thrown in there?—To shut out a portion of the tidal flow.

503. How high up the Cart from the Clyde does the river Gryfe flow in to it?—About two miles and a half up.

504. What depth?—Barges carrying 40 tons can ascend up the River Gryfe.

505. Has the water suffered any decrease in depth by the accumulation of peat?—A vast quantity was lying in the bed of both the Gryfe and Black Cart.

506. Why did you not remove it, if you are of opinion that it would decrease the tidal flow?—It was thrown in by Mr. Spears, a proprietor in the neighbourhood, who was removing the black stone moss.

507. Did he make any application to any body?—No; but the Clyde trustees instituted proceedings against him.

508. What was the result of those proceedings?—I believe they are still at law.

509. Then they have endeavoured to prevent it?—Yes; and in order to show the great value of the preservation of the back tidal water there is an Appendix appended to that Report, which is very short, which shows the great value which the people on the Continent give to a back water scour to harbours generally. (*See Appendix*, No. 5.)

510. Are you of opinion that much benefit can be derived by reservoirs for scouring?—Yes; the harbour of Dunkirk was an example of it.

511. Is it your opinion that every tributary, however small, of the Clyde or any other river which you wish to keep navigable should be kept open?—Every auxiliary branch should be carefully preserved.

512. The destruction of every auxiliary tends to injure the flow, and consequently to destroy the principal harbour?—There is no question of it.

513. Has the machinery for deepening the Clyde navigation been improved since 1839?—Yes; there has been a new dredge board built capable of working in from 17 to 19 feet depth of water.

514. With that you have been working?—Yes.

515. Did you suggest any further improvement, and has that been adopted?—Yes. I suggested an improvement to work the boats forward by steam power instead of manual labour, by which the deepening force was enabled to raise annually about 80,000 cubic yards or more additional, &c. &c. &c. (*See Appendix*, No. 3, before referred to.)

516. With a saving in labour and an increasing of work?—A saving of manual labour and an increasing of work of about 80,000 cubic yards annually. I got a tug boat built with two engines, each 30 horse power, which boat and engines have given the greatest satisfaction, the engines were made according to a specification, and were executed by Messrs. Smith and Rodgers, of Glasgow. Two years ago I got a model made for a new diving bell boat, to be formed of iron, and to have improved diving-bell machinery placed on board of her, for the purpose of lifting the large stone boulders and rocks from the channel bed of the Clyde, which damage and destroy the copper on the bottom of the large ships, whereby the timber becomes immediately exposed to the ravages of the teredo navalis; such ships going long voyages are placed in the most imminent danger; lives and property are perilled when they sustain such

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damage. Therefore every exertion should be made to remove all the rock boulders and stones from the bottom of the ship channel of the Clyde, and which ship channel through all its hard and rocky parts, should be deepened and widened to a much greater extent than any other part of the channel, because when a large copper bottomed ship, deeply loaded, grounds for want of tide water, on any part of such a hard and dangerous bottom, she must inevitably be seriously injured, not only as regards the copper on her bottom but also twisted or strained in her framing. The proposed new iron bell boat, which I had recommended, has not yet been made. It may be reasonably asked, what are a few hundred pounds paid for such a boat, and the annual expense of working her, compared to the loss of even one of those large ships and cargoes, worth perhaps in value, some of them, not much less than 40,000*l.*? Notwithstanding all this, there is lying on the table an order dated April, 1842, (in the hand writing of the late Mr. John Spreull, treasurer to the Clyde trustees,) addressed to the river foreman, directing him to discontinue the working of the two diving bells, and consequently, any further removal of those stones and boulders of rock from the bed of the channel of the river; and observe, this done in my absence, while in London on the trustees' business. With regard to improving the deepening machines, by still further increasing their power and labouring force, I shall hand in some extracts from my reports on this important subject, and also the copy of a letter which had been addressed to the chairman of the Committee of Finance. (*See Appendix*, No. 6.)

517. Can you state shortly the extent of the works which have been executed in the harbour of Glasgow and the river Clyde since 1839?—There have been executed and finished 1120 lineal feet of stone quay walls; 160 lineal feet of stone breast quay walls; 1032 lineal feet of wooden wharfs, including Bowling Wharf; 1447 lineal feet of new sheds; 3703 lineal yards of water-pipes; and 101 fire plugs. Bowling Basin contains an area of 14 acres. Govan Ferry Slip and quay wall 170 feet long. The harbour has been enlarged to an extent of more than seven acres. Many hundred feet of old quay wall on the north side of the harbour have been secured by piling 40 feet long each, and plans have been drawn out to secure a part of the south quay walls of the harbour which are now in progress of execution.

518. Have these seven acres of area been an addition to the place where ships can lie?—Yes, an additional surface of water.

519. Within what limit have these seven acres of space been added to the harbour?—Within less than a mile.

520. What effect have those works that you have mentioned had on the harbour?—These works have increased the accommodation for the trade considerably.

521. They have had no effect in deepening the water, but that has been done by dredging?—By dredging and in the construction of those dykes down the river.

522. You state them as an improvement to the harbour accommodation?—Yes.

523. (*Chairman.*) Ships of what draught of water can float in, in the increase of seven acres?—From 16 to 17 feet in the part deepened in the lower harbour.

524. Ships of 500 tons?—Ships of 600 tons in the lower harbour in part of the deepenings.

525. (Mr. *Hume.*) Have you any further information to give?—I beg leave to read the following document:—"Mr. Mnconochie is directed to discontinue working the Rashalee Quarry, and to lay up the stone punts till further notice. To employ no more men in repair of the sloping dykes than will keep them from falling down. To discontinue working the diving-bells, and, when laid up, to employ only one man to look after both bell-boats. To pay off what men can be spared in the harbour—say masons, joiners, smiths, causewayers, or labourers, and to give notice that the surveying party are not to proceed with taking soundings above Bowling Bay. Glasgow, 18th April, 1842."

526. What is your object in reading that?—There are about 2200 yards of the bed of the channel of the Clyde incumbered with large whinstone boulders, between the west end of the New-shot Isle, and Erskine Ferry. It became important that those boulders should be removed out by the diving-bells. This order was given in the beginning of the season to discontinue the working of the bells, when the days were long, when the tides were low, and when it was absolutely necessary to remove those immense boulders; for this reason—that the large vessels going up and down the river got their copper sometimes stripped off by those boulders if they touched the bottom. I continued the working of the two bells in clearing the channel since that period up to the present, and disobeyed this order.

526. By whom was that order given to discontinue the works in 1842?—I am not able to answer, but the hand-writing is the late Mr. Spreull's, treasurer to the trustees, and it was handed to me by the river foreman on my return from London, and it was, no doubt, issued under the official authority of the chief of the executive department.

527. Did you remonstrate against that order of the trustees?—I remonstrated to several of them, and I persevered in keeping the bells on the hard ground; and I covered a space near the entrance of their meeting chamber with the fragments of sheets of copper and pieces of iron and lead which had been stripped off the bottom of large vessels, and which had been taken up by the diving bells from the bottom of the navigable channel in the river; and when they saw those fragments, and the serious injury which the bottoms of the ships had sustained, they were convinced of the propriety of my proceedings in persevering with the diving-bells and removing those boulders out of the bed of the channel of the river.

528. Have all those boulders been removed?—Not entirely; there is a good deal yet to be done both in widening and in deepening the navigable channel. It is the most dangerous part of the whole Clyde navigation to ships.

529. Are they now at work upon them?—Yes, I believe they are with the diving-bells.

530. (*Chairman.*) Then the operation of these diving-bells was suspended merely temporarily; how long were they laid up?—I am not aware that they were laid up at all. Orders were given, and the orders were disobeyed on my return from London to the Clyde.

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531. (*Capt. Beaufort.*) Can you state anything like the quantity of whinstone boulders that they remove?—Year ending 1843, there were removed 969 tons, and year ending 1844, there were removed 1033 tons. There is a regular account kept what each bell lifts per day, per week, per fortnight, and also of the dredgers.

532. (Mr. *Hume.*) Were any other works begun by you as necessary to improve the navigation, interfered with and stopped by order of the trustees?—None, except the opening of the south channel of the Newshot Island.

533. Was any complaint made against you for persevering in using the bells and clearing the boulders, notwithstanding that order being given to your deputy?—None, the numerous fragments being shown of copper, lead, and iron, taken up by the bells from the ship channel of the river, and which had been torn off from the bottom of the ships by the rough rocky ground, settled that question effectually with the river trustees.

534. (*Chairman.*) Then you are of opinion that your acting on that order would have been most injudicious and prejudicial to the river itself?—Highly injurious to the navigation, and dangerous in the extreme to the shipping engaged in the foreign trade.

535. (*Capt. Washington.*) Can you tell us the expense of dredging in the Clyde?—The least expense is about 8*d.* per cubic yard; and the greatest about 1*s.* to 1*s.* 3*d.*; it is according to the nature of the material to be dredged, and the distance of depositing it.

536. (Mr. *Hume.*) Can you state the aggregate amount raised by dredging from the bed of the Clyde in the six years you have alluded to?—I will furnish an abstract of the whole of the results. (*For which see Appendix,* No. 3.)

537. (*Capt. Beaufort.*) Have you blasted any of those whinstone boulders?—No, the bell generally raises them.

538. (Mr. *Hume.*) What is the largest size of any of them?—From four to five tons. They are bored on each side, small lewises put in, chains fixed and raised up by the machinery of the bell. Boulders so large as five tons are raised in this manner from the bed of the Clyde.

539. Where do ships get ballast at Glasgow?—There is generally ballast laid down on the quays, and that ballast goes away in vessels again.

540. (*Capt. Washington.*) What is the material you dredge up chiefly?—Fine sand, coarse sand and gravel, mud and sand mixed, clay, running sand, and mud and sludge.

541. Do you consider it to come from the upper country, or from the sea water chiefly?—From the upper country, and the sewers of the city.

542. (*Capt. Beaufort.*) No shell sand amongst it?—It is destitute of sea-shell sand as far down as Bowling. The sand depositions at Bowling contain minute fragments of coal, which announce that it has come from the higher part of the river down to that point.

543. (Mr. *Chapman.*) What proportion does a cubic yard bear to a ton?—I think on an average in the Clyde, from 18 to 20 cubic feet, is equal to a ton. I have a book in which I have entered the number of cubic feet to the ton, which I had found the various strata to contain along the Clyde; wet and dry pressed and loose. It is not here, but I will furnish it if required.

544. (*Capt Beaufort.*) With respect to your opinion that the injury that occurs to any river from cutting off any of the tributary streams, are there no cases in which it might be useful to direct the channel of the river, even at the expense of cutting off a considerable portion of the salt water?—In general I think any operation of engineering that shall prevent any portion of the tidal flow from ascending up any auxiliary stream, would be injurious to the scour.

545. Will you state the principle on which you found that opinion?—The principle is, that anything which would diminish the quantity of tidal flow, I should think would be injurious to the scouring power, and to the navigation.

546. Then you make no exceptions to that principle at all?—I am not prepared at this moment to make any exceptions. But if the question be to improve by straightening the crooked or winding channel of a navigable tidal river, in making it more direct, shorter, and easier to navigate, I would not hesitate to recommend such an improvement, even although it should abridge a small portion of the water area; such for example as cutting a direct and wide channel from the town of Belfast down to the deep sea, substituting in this case a straight and shorter channel for navigable purposes to a crooked and lengthened one. All such cuts in my opinion should be trumpet mouthed, gradually increasing in width from the upper part where the cut would commence down to the lowest where it would terminate at the deep sea; and such cuts might even sometimes be made to such a width as to contain an area nearly equal to that of the old crooked channel, thereby losing none of the area of the tidal water surface, and again cases may occur where gentle and easy bends might with great propriety be substituted for direct cuts, thereby lessening the expense, and still preserving all the necessary facilities required for navigation.

[*The Witness withdrew.*]

The Lord Provost of Glasgow and Others.

The Lord Provost of Glasgow,
Mr. *Charles Gray*, Deputy Chairman of the Clyde Trustees,
Mr. *Angus Turner*, Secretary to the Clyde Trustees, and
Mr. *James Walker*, Vice-President Inst. Civil Eng., F.R.S.
} Examined.

547. *Chairman.* (To the *Lord Provost*). You have read the evidence of Mr. Bald?—I have.

548. Is there any information you can give the Commission with regard to that evidence?—I considered it necessary to consult Mr. Gray, as I am simply the *ex officio* chairman of the Clyde trustees, but the principal details more immediately fall under the charge of the deputy

chairman, and the committee of management; and I must refer the Commissioners to Mr. Gray and Mr. Walker, who are now present.

549. (Mr. *Godson*) (to Mr. *Gray*). Are you the deputy chairman of the Parliamentary trustees of the river Clyde?—Yes.

550. Are you also the chairman of the committee of management?—Yes.

551. How long have you been so?—I have been a member of the Trust since November, 1841, and chairman of the committee of management since November, 1843.

552. Under what Act of Parliament is it you now act?—The third and fourth Victoria, chapter 118.

553. During the time that the improvements have been going on in the Clyde, what gentlemen have you consulted as engineers?—Before I was a member of the Trust, the eminent engineers of the day were consulted, including Mr. Smeaton, Mr. Golborne, the late Mr. Rennie, and Mr. Telford.

554. Who is your present engineer?—Mr. James Walker of London.

555. Are there any plans for the improvement of the river, made by Mr. Walker?—There were plans made by Mr. Walker when the Act of the Third and Fourth of Victoria was obtained, in 1840.

556. Has that plan been worked by, or has it been modified?—It was modified to some extent.

557. By whom?—The modification was sanctioned by Mr. Walker.

558. Have you any resident engineer?—Not at present. Mr. William Bald was the resident engineer and superintendent until about a month ago.

559. Have you not yet appointed any successor?—No successor has yet been appointed.

560. In whose care is the river in the place of Mr. Bald?—Mr. Bald had a deputy, Mr. M'Conochie, under whose charge the operations are at this time.

561. When Mr. Bald left you, was there any report made?—Yes.

562. Have you got that report?—Yes.

563. Will you hand it in?—I will. (*The Report was handed in.*)

564. Is there any railway about to be made near Glasgow?—There are several railways projected in the neighbourhood of Glasgow.

565. Are there any that will interfere in any manner with the Clyde river?—Yes; one is the Glasgow Junction Railway.

566. Have the trustees had any application made to them respecting that railway?—They have had application to know whether they would dissent or assent to the scheme when it was first brought forward.

567. What did they resolve to do?—They resolved to oppose it.

568. What have they done?—They presented a petition to Parliament against it, and have taken the requisite steps to oppose it in Committee.

569. When you speak of the opposition, and that a petition was presented, you mean to Parliament?—Yes.

570. Was any thing done in the way of taking advice at Glasgow, or the opinion of the people?—The opinion of Mr. Walker was asked, but has not yet been received, as to the Glasgow Junction Railway; it was resolved to oppose it in Parliament.

571. Has the opinion of Mr. Walker been requested respecting laying rails on the quays generally without relation to any particular part?—In conformity with a resolution of the 8th April last, the opinion of Mr. Walker has been asked.

572. Has any answer been received?—Not yet.

573. Have any instructions been given to Mr. Walker?—Instructions have been given to Mr. Walker in the printed letter which is now handed in.

574. There have been two general meetings of the Clyde Trustees, held on the 1st and 8th of April, in relation to the proposed railways. Have the minutes of those meetings been submitted to Mr. Walker?—Yes.

575. Have you the minutes of those meetings?—I have handed them in as part of Mr. Walker's instructions.

576. Have you made any arrangement respecting the waterworks at Glasgow?—At present, by the Act of 3rd and 4th of Victoria, the trustees are bound to maintain the water level for these waterworks.

577. What is that level?—I cannot exactly state the level above low water.

578. Where was the old weir that supplied the waterworks before the last Act of Parliament?—At the Glasgow or Jamaica-street Bridge.

579. Where is the new one?—At Stockwell-street Bridge.

580. Have you any intention of removing the weir higher up the river?—There is a Bill now before Parliament to effect that object.

581. How far higher up the river is it proposed by that Bill to put the weir?—About 1,100 yards; about 140 yards above Hutcheson-Town Bridge, to maintain the water at the same level as at present.

582. (To Mr. *Turner*.) Could it not be removed higher up the river than that?—It could not at present. It would injure other factories; two or three of which are secured in their rights by statute.

583. (Mr. *Hume*.) Is it a supply of water that is secured to them, or the locality of the weir?—It is rather a supply of the water; that is, that in general the level of the water at their works should be secured.

584. If they could obtain a supply of water to that level, do you apprehend there would be any objection to the removal of the weir?—If they and the other factories were to obtain that supply, I do not think there would be any objection to the removal of the weir.

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585. Are there any other parties who would object to it?—A great many in the upper reaches of the river. I suppose not less than 10 additional factories along the banks.

586. Are all the factories equally secured by statute?—No, only two, in addition to the water company.

587. Then the objection of the others might depend on other grounds altogether?—Yes.

588. Are the waterworks' rights dependent on statute?—They are.

589. Are you able to say whether they would have any objection to remove the weir, provided they had a supply of water higher up?—I believe they would have none whatever.

590. (To Mr. *Walker.*) What height is it proposed to raise the water at the Hutcheson Town Bridge?—Giving a comparison between high and low water I will say that the water will be placed to such a level as to support the low water of the river before the Clyde improvements began below the bridges.

591. How much lower does the tide fall since those improvements in the Clyde took place than it did before?—From 2 to 3 feet.

592. Then the weir if established would stop the flux of the tide till it rises above the level?—Yes.

593. How high above that does the tide flow?—Above two miles, but the flow is very small.

594. Up to that extent the water may be impeded?—Yes, an impediment to the ebbing of the water.

595. And to the scour?—I have always been of opinion that the tide has little if anything to do with the scour there at all.

596. Will not that portion of the water obtained by the weir if allowed to run tend to carry off any deposition in the harbour below it?—Yes, it is nothing but a tendency; the practical result I have always considered has amounted to nothing. The tendency I have always been desirous of encouraging, because I like to see a tide go up and return as far as it possibly can. I have always been of opinion, and I have so stated in a variety of cases, that the state of the river at Glasgow did not at all depend on the tide, but on the river freshes.

597. Does not every fresh tend to bring down water and deposit in the harbour?—It brings it down, but it carries away a great deal more matter than it brings down.

598. If this would tend to prevent the scour of any portion of the ebb, will it not to that extent also lessen the scour?—That would be its tendency. The tide has so little to do with it that when there is a fresh in the river, the tide is not sensible even at Glasgow.

599. That is while the river is full of the fresh?—Yes, the tide never runs upwards. The velocity due to the tide in the river immediately below Glasgow is not, perhaps, (I am speaking from recollection,) one mile per hour, the velocity due to the fresh is from four to five miles per hour, therefore I consider that so high up as that, the river or fresh water is the only scour.

600. (Mr. *Godson.*) That being your opinion, are you also of opinion that there should be no such thing as a weir in the river at all?—Yes. As there is a certain quantity of water coming down, and that quantity must go from the upper part of the country down to sea, it does not follow that the scour should increase as the depth increases; quite the contrary, because from the upper part of the river above where the weir is, the velocity is very great indeed, because the section is small; but when you get below Glasgow Bridge, where the operations of the Clyde trustees have made a very large spacious river, the velocity of the fresh is very much less.

601. Is or is not the improvement of the river impeded by having any weirs at all on the river?—I have already said that in that part the tendency is so, but I say that practically it has not that effect as regards the scour in the river.

602. (Mr. *Hume.*) What is the depth of the water in the weir at low water?—On one side of the river there is no depth at all, on the other there is a gully caused by the weir, and the bridge, which is as much as fifteen feet deep, there is an immense hole. Below that again, there is, as there always is in such cases, a rise, or bar, and then at low water below Stockwell-street Bridge the whole river almost, except just the narrow part, is dry land. Gentlemen who have seen the Clyde at low water are aware that immediately above Glasgow Bridge, until the Glasgow trustees began to deepen it, at low water, the river was confined to a very narrow width.

603. Is not the existence of a weir to create these deep holes and banks afterwards an injury to the navigation?—Yes; but until very lately there has been scarcely any navigation up there at all. I have been very desirous if it could be done, (and I am quite ready to take professionally the whole responsibility of what is done upon myself,) I was very desirous to get this weir removed up a great way higher and designed that place at Dalmarnock.

604. Is not that an object most desirable to be effected with a view to improving the general navigation?—Yes. If that were done and the river deepened, then the navigation of that particular place would be improved.

605. If that weir was removed and the same means applied to deepen the river from the bridges upwards to Dalmarnock, would not the navigation of that portion of the river be improved?—Yes. There would be navigation then where there is none now. It would, in fact, be a very large basin and dock, and would extend the harbour of Glasgow up to the place where the weir would be.

606. Is not that a most desirable object to be obtained for the navigation above the bridge to improve the harbour if by arranging with other interests that can be effected?—The navigation above the bridge could only extend to the navigation of that pool, or dock, or basin formed by it, and the parties who will receive the benefit would be the owners of the property adjoining. As regards the improvement of the river below the bridges I have already said that practically I think it would have no effect.

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607. Might not barges go up where now they do not go?—Certainly.

608. Would not that extend the length and accommodation of the harbour, leaving the centre for large ships, while the smaller boats and vessels might go above?—Yes, and that I have recommended; but I would say, that to do that would be a very important, and a very large measure of itself. It is not only as regards the waterworks, but the river being kept up to its present level, if the whole weir were removed, and the fresh to come down, it would scour the bottom of the river to a very great depth; that scour would go up as far as any other point at which you place the weir, and the effect of that would be to widen and to increase the river there, and to bring in the banks, and one of the probable effects would be the destruction of Rutherglen Bridge, which is above it. Still I should like a new bridge built where Rutherglen Bridge is, with the piers much deeper than they are, and I should like everything done which would allow a free ebb and flow of the greatest possible extent, but I am quite prepared to say most sincerely that advising it as I at first did, I was perfectly sure that the trustees of the river Clyde could not carry it in the measure now before Parliament, that they would have failed in their Bill altogether, if they had attempted to do what is now proposed. They removed it first from Glasgow Bridge up to Stockwell-street Bridge, and they are now in the way of removing it again from Stockwell-street Bridge, up to above Hutcheson Bridge, and the time may come when they may have the means of carrying it higher.

609. If the plan be a good one to clear the navigation to the utmost extent of the tidal flow, what is the opposition you contemplate?—The opposition is the water-works, Rutherglen Bridge, the supply of water to the manufactories for which pipes are laid, and the effect on the property on the banks of the river. I think after what I have already said, I need not repeat that that which is called a weir is simply to keep up the river in its old state.

610. The water, in fact, prevents the improvement being made above which has been made below, in respect of deepening the harbour?—Yes.

611. Do you see any objection, except that of the bridge, to the clearance being made, provided the water-works and companies can be supplied with water from the high sources of Dalmarnock, to which you have alluded?—I see no reasons but those I have named.

612. Have you ever contemplated any substitute to supply those water-works and manufactories, so as to enable you to carry out the improvement in the bed of the river by the removal of the weirs which you have stated to be desirable?—I have.

613. Any estimate?—There was no estimate made of it; it never got that length.

614. What was your plan?—The plan was to have a large pipe carried from above the weir that would then be at Dalmarnock, across a neck of land immediately down to the protected factories. I have already said that a weir made at Dalmarnock would supply the Glasgow Water-works as they are supplied at present. Then the Cranston Hill Water-works would either be supplied through this pipe, or (which I think would be a better plan), they might be demolished altogether, and their power added to the present Glasgow Water-works, so as to make one great establishment above Dalmarnock Bridge. I contemplated both plans, and did what I could with the engineer of the Company, to endeavour to arrange such a plan, but I found the opposition to it so great, and the objection so formidable, that I recommended the trustees in the present Bill not to include so much.

615. Is there any legal authority for erecting a weir at Dalmarnock?—No, not at present.

616. Then what necessity would there be for erecting one at all there?—The Glasgow Water-works could not be protected without erecting one.

617. That would be to supply water for the works?—Yes; the water could not be kept up.

618. (Mr. *Godson.*) (To Mr. *Gray.*) Do the trustees look forward to the ultimate removal of all the weirs on the river?—They contemplate the possibility of that.

619. In what way do they contemplate being able to do it?—They contemplate at some time to do it in the manner Mr. Walker has named.

620. Have you any information to give respecting Newshot Island; what difficulties have you found?—It is understood that the bottom of the south channel is rocky, and parties having property along the north side of the river would object to the navigable channel along their property being shut up or changed, and the further expense, probably 8000*l.*, would be much more than any advantage that would result from it.

621. (Mr. *Hume.*) Would not the river be almost straightened by taking the south channel instead of the circuit to the north of Newshot Island?—The channel would be straightened, but I would rather refer that question to Mr. Walker.

622. (Mr. *Godson.*) When you say it would interfere with the property, is it property that you are alluding to above or below low-water mark?—Above high-water mark.

623. When you speak of dealing with the river, have any persons claimed to put anything into the river so as to have vested interests in it?—They claim the land formed by dykes that were made long since.

624. That is what you mean by the word property?—Yes. (Mr. *Turner.*) It should also be mentioned that the trustees lately proceeded to remove one of the old dykes below the south channel at Newshot Isle, and the immediately adjacent proprietor objected to that. He held that the dyke, having been there for a period of upwards of 40 years, the trustees had no right to remove that dyke; that he had a vested interest in the continuance of the dyke, because the land was making up behind the dyke, and increasing, in this way adding to his estate, and the trustees rather than try the question allowed the matter to remain for the present in abeyance.

625. (Mr. *Hume.*) (To Mr. *Turner.*) Was not that dyke put in originally to improve the navigation of the river?—To improve the north channel.

626. If it were found that instead of improving it deteriorated it, have not the Commissioners or trustees, the power to remove that which they put in?—I think they have in point of law.

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627. (Mr. *Godson.*) Do the proprietors of the bank say they have not?—That is the bone of contention.

628. (Mr. *Hume.*) Has any opinion been taken from any legal authorities as to that vested right claimed by the proprietors of the south shore?—I should mention, with reference to the rights of the land-owners at this place, that when the last Act was obtained, Mr. Campbell, of Blythswood, the proprietor of Newshot Island, contended that the operations on the river would have the effect of washing away the banks of the island, and there is a set of clauses inserted in the existing Act which protect the banks as belonging to Mr. Campbell, thereby, so far, recognizing and strengthening the right Mr. Campbell conceived he possessed as an adjacent land-owner. It was recognizing by statute the right of the land-owner to access and protection to his banks.

629. Did that statute give him any right to go into the centre of the stream?—The legal difficulty I conceive is this, that as the navigable channel for a long period of time, from the earliest date almost, has been into the north water-way; and the question is, whether, in point of law, the rights of the public to the southern channel may not be lost for navigable purposes; whether it has not become merely an inlet of the navigation.

630. Has any legal opinion been taken on the subject?—Not on that identical point.

631. (*Chairman.*) Has any legal opinion been taken as to the right of the proprietors of the adjoining soil to the constantly accumulating land?—That question is fixed to a great extent by the statute. The right of the land-owner to the soil extends to the north and south of the dykes, respectively, on both sides of the river. Previously to the passing of the Act of 1840, there were several questions depending between the trustees and the land-owners. The question first came before the Court of Session, and then came by appeal to the House of Lords, and the House of Lords held that the Clyde Trustees were entitled, for the purposes of the navigation, to the land which formerly constituted a part of the bed of the river. That was so decided, but there were specialties in the case referred to, connected with the title of the parties to the land which so far aided the general argument of the trustees, and the proprietors contended that the decision in that case could not rule the other questions. We were still involved in litigation with the proprietors in relation to the several interests of the different proprietors along the banks. As the general question, it was contended, could not be held to be fully adjudicated, they appealed to Parliament; and the Clyde Trustees by the interposition of Parliament, during the dependence of the Bill of 1840, and with a view to get forward with the measure, consented to a medium course; and in regard to a large portion of the land-owners they made a compromise, by which the trustees were to be entitled to take the land within the ancient alveus of the river required for the purpose of their works on paying one-half of the price.

632. Then, by that Act, I understand you that the trustees gave up in fact their own right, to avoid opposition?—They conceived that the opinions they obtained from lawyers were so doubtful that they could not find themselves justified in involving the funds of the navigation in expensive law suits; seeing the amount at issue was not very great altogether, they thought it preferable to make a compromise as suggested by the Committee on the Bill, and to give up the one-half of the price, whatever it might be. In consequence of this arrangement the Commissioners of Woods and Forests came forward, and they said that if there be any compensation due to private parties at all it was due to the Crown, and there is a very stringent clause inserted in the Clyde Navigation Act recognizing the rights of the Crown, and reserving entirely the claims of the Crown to the property situated within the ancient alveus of the river. Since the date of this Act of Parliament we have had several jury trials, in which the value of this portion of property has been ascertained. The trustees, under the provisions of the Act, consigned the value so ascertained as in a question between the trustees and the proprietors. The Commissioners of Woods and Forests appeared in the judicial proceedings, and claimed the price of the alveus portion of the consigned land, and have been successful in these proceedings. In point of fact the Woods and Forests are now in possession of funds to the extent of about 1700*l.*, money so acquired, being the price of the one-half of the alveus adjudged by the jury as applicable to the interests of the proprietors on the footing of the statutory compromise being effectual against the Crown. The Woods and Forests have said in our negociations with them that in so far as regards the one-half which the trustees were not bound to pay for, they would exact no price from the trustees, but only prevent private parties, in consequence of the arrangement in the Act of 1840, benefiting at the public expense by taking a price for land which the Woods and Forests conceive not legally to belong to them, because they contend that if it does not belong to the Clyde Trustees it belongs to the Crown.

633. Do not those decisions that you have now stated, and the measures that have resulted from them, substantiate the right of the public, in the name of the Crown, to the alveus land, formerly covered with the tide flow?—I think they virtually do.

634. If these rights of the Crown have been so substantiated, why did the trustees interfere to prevent portions of the dyke being removed, which were considered by the engineer to be beneficial to the navigation?—Mr. Bald, looking to the state of the river, thought that that portion of the dyke at Newshot Island might be beneficially removed, and he did suggest to the committee of management the removal of the dyke. Mr. Walker was not then consulted upon that point. The trustees, however, knew that Mr. Walker considered that dyke was by no means essential to the navigation. It is a half-tide dyke; it did not present any material obstruction to the flow of the tide upwards, the flood tide gets easily through that dyke and above it, and we have the full benefit of the flow of the tide notwithstanding the dyke. The trustees are not solicitous of trying mere abstract questions of law with proprietors, and getting into disputes with landowners, if they can avoid it; their policy is to live in peace with the landowners if they can, and they did not think this was a question involving essentially the interests of the river,

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and they thought it more suitable for a public body of trustees dealing liberally with landowners along the banks, not unnecessarily to try questions of this sort; and as it did not form a material portion of their works, they rather left the matter in abeyance. There is no acquiescence on the part of the trustees, but they did not think it a question which justified them in going into a court of law.

635. Did not the resident engineer give it as his opinion that the navigation would be benefitted by removing that, and did he not actually commence by removing a portion of the stone?—He did certainly give his opinion, but the trustees were also advised by higher authority that it was not essential.

636. You say reference was not made to Mr. Walker; to what occasion do you allude?—I mean on that identical occasion reference was not made to Mr. Walker; but the Act of 1840, only passed a few years ago, and we were quite familiar with the questions as to Newshot Island. We knew Mr. Walker's opinion intimately.

637. Did not Mr. Henderson, the proprietor of the land adjoining, remonstrate with the trustees, and did they not, upon that remonstrance, or after that remonstrance, stop the proceedings?—They did not proceed to try the question with Mr. Henderson in a court of law.

638. Did they not prevent the engineer from going on with what he had begun?—Certainly. The trustees must not be supposed to have sacrificed the interest of the river; because I would mention, in explanation of their instructions to the engineer, that they did not conceive it to be a question that justified them in raising unnecessarily a legal question with a landowner about a dyke not material to their works.

639. Do you not consider the removal of every obstacle to the flow of the water upwards, of consequence to the general navigation?—More or less.

640. Do you not consider it would have been the duty of the trustees to remove an obstruction that might have given perpetual improvement?—In the abstract, I should say unquestionably it would; but every case of that kind depends on the importance of it.

641. (Mr. *Hume.*) (To Mr. *Walker.*) Are you aware that Mr. Bald, the resident engineer, began to remove a dyke on the west side, with a view of promoting the flow of tide in that direction?—Yes.

642. Do you consider that the removal of that, with the view of making the channel to the south side of the island, instead of the north, would have been beneficial to the general navigation of the Clyde?—If the change could have been effected from the north to the south side entirely, of course it was right to begin it; but it was extremely wrong in Mr. Bald to begin it, for two reasons, one was, that he had no orders to do it; and another was, that at the very time he was doing it, he was doing an injury. Unless it was previously resolved to change the channel from the north side to the south side, the current of the river could not support a channel on both sides, and therefore, by removing the dike, and allowing the scour of the river to come into two directions, in place of one, the effect was to allow the chief channel to silt up. The question will come, therefore, to this, whether the trustees of the River Clyde did wrong in making the northern channel the navigable channel, rather than the southern side.

643. (*Chairman.*) Are you of opinion that the trustees exercised a sound discretion when they prevented Mr. Bald from carrying on the work he had begun?—I am.

644. (Mr. *Hume.*) Did they consult you upon that occasion?—Mr. Bald was sent up to me I think about that time. I have a memorandum in my hand, which was made in August, 1839, when Mr. Bald was present with me. These were instructions that I gave to Mr. Bald when he came up to me.

645. Was he directed to put himself under your instructions?—He was directed to come up to me for instructions, that was in 1839.

646. (To Mr. *Turner.*) Was that after his appointment as resident engineer?—Yes.

647. (To Mr. *Walker.*) What is the memorandum?—"Newshot Island. Mr. Bald thinks the question of the best course for the navigation here should be investigated; that the south course would be 200 yards shorter than the present course, north of the island; that there being a rocky bottom, is an objection in the south channel. Mr. Walker stated that the subject had been investigated by Mr. Logan, and that his (Mr. Logan's) reasons, (Mr. Logan was the predecessor of Mr. Bald,) must have appeared to him (Mr. Walker) satisfactory, although he (that is myself) does not remember all. Mr. Rennie, and Mr. Telford, as well as Mr. Logan, having preferred the north channel, was adduced, as a proof of the north being the better. Mr. Walker, however, agreed in the importance of the matter, and to Mr. Bald's investigating the facts."

648. After that interview between Mr. Bald and you, did Mr. Bald investigate as then advised?—I think he did.

649. Did he make any report to the Commissioners on the subject?—I do not remember what report be made to the Commissioners, nor do I know the fact.

650. Did he make any report to you?—I think not.

651. When it was left to him to investigate, do you not think the trustees ought to have consulted you after the recommendation he gave to them, that the channel would be greatly increased by adopting the south instead of the north?—I have no doubt the trustees asked my opinion.

652. (To Mr. *Gray.*) Has not the Clyde been greatly improved and deepened during the time Mr. Bald has been engineer?—Not materially deepened I think.

653. Are you aware whether there is any increased depth of water in the harbour, or in any of the shoals below that opening of the river, since Mr. Bald's appointment took place?—Considerable, more particularly at Port Glasgow Bank; the harbour is not much deeper.

654. Are you prepared to show it is not much deeper. Has there not been a depth of water exceeding three feet along the quays?—It is about two feet.

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655. Do you speak from the examination of any other engineer, or from the report of Mr. Bald?—From what Mr. Bald has told me himself.

656. Has he not reported in writing the depth of water that he has gained?—Not exactly.

657. (Mr. *Chapman.*) Does he not attribute it to dredging?—The deepening of the Clyde is owing to dredging.—(Mr. *Turner.*) The fact is the only soundings that have been taken, at least the only soundings the trustees would be disposed to be responsible for, in any form, were those taken at the time of the passing of the last Clyde Navigation Act. They then got the river sounded by a person in whom they had the utmost confidence. Those soundings were proved before Parliament, being taken with great care. Since that period no regular soundings have been taken, and all that can now be stated as to the improvement since Mr. Bald became engineer is just simply that the trustees have been exerting themselves to the utmost in making every possible improvement; they have been sparing no money that was at their disposal to accomplish this; and Mr. Bald has been the instrument, under their direction, in accomplishing that object, but he had little more to do with it than I might be said to have had in writing the minutes of the trustees, carrying out resolutions, with a view to the improvement of the river.

658. (Mr. *Hume.*) He has been executive officer?—He has been superintendent under Mr. Walker's directions.

659. Are there any minutes of the trustees directing him to remove the boulders from any portion of the river?—At the meetings of the Committee of Management Mr. Bald usually attended, and they do not think it necessary in carrying out the details of the works to make minutes in all cases instructing Mr. Bald to do so and so. The course is this: I recollect, for instance, that Mr. Burns, who is one of the largest steam-boat owners in the Clyde, on one occasion complained to the Committee of Management that the bank at Port Glasgow was an obstruction to steam-vessels, and he submitted to the trustees that Mr. Bald should send down the dredging-machines, and Mr. Bald was instructed by the Committee, on Mr. Burns' motion, chiefly, to effect that improvement. It was done under the immediate instructions of the Committee of Management, emanating from Mr. Burns chiefly.

660. Take another example:—opposite the end of Newshot Isle, where a collection of large boulders existed. Were there any minutes of the Board directing him to remove them?—In relation to these shoals in the river, they are generally brought before the Committee in this way: the members of the Committee themselves are constantly going up and down the river, and meeting with steam-boat masters, and hearing complaints as to particular inconveniences in the river. When such complaints are made, one member or another brings the matter before the Committee of Management. Mr. Bald is instructed, if there is a greater shallow in one place than in another, to place a dredging-machine upon it. I do not remember that Mr. Bald of his own accord, without some proceedings of that sort, or without first reporting the circumstances to the Committee, ever has undertaken any work of consequence. No doubt if Mr. Bald did see a shallow he would mention it, but the Committee going so frequently up and down the river, and communicating with the steam-boat owners and masters, and those who were suffering from inconvenience of any kind, they, themselves, are in the practice of bringing such matters under consideration of the meetings, and the engineer's attention is directed to the most pressing portions of the river accordingly.

661. Has not the engineer reported annually, and from time to time, to the Commissioners?—Latterly he has been reporting monthly.

662. From the time he was first there has he not been in the habit of reporting?—There has been several reports.

663. Are we to understand that the Board were rather directed by the anonymous kind of information received from masters of ships than from the written opinion of Mr. Bald?—I do not state that they were directed by any anonymous information. I stated that matters of that description, as for example, the removal of a particular shallow, or the bank at Port Glasgow, or the removal of boulders, that these facts often came directly to the knowledge of the Committee of Management from persons who were suffering inconvenience from them. The owner of a ship might complain, "My ship struck on a shallow." That is immediately brought before the Committee, and they ask Mr. Bald how is this, you must send a machine to get the shallow removed. It is not done from any anonymous information, but from the statements of parties suffering from the inconvenience.

664. Do you know at any time of the Board having forbidden the removal of the boulders?—No.

665. Look at that document, whose writing is it? (*handing the same to the Witness*)—Mr. Spreull's, the late treasurer.

666. Had Mr. Spreull, as treasurer, the power of interfering with the work of the engineer?—None whatever.

667. Are the diving-bells employed to remove boulders?—They are.

668. Is not that, therefore, an interference to prevent that very work being carried on?—It would appear to be so, but how he came to give these instructions I cannot conceive. The only explanation I can give of it is, that I remember the trustees, in consequence of enormous purchases of land they had made for the purpose of enlarging the harbour, and having had several jury trials, and in one of them, I think, they paid as much as 58,000*l.* under one verdict. The trustees came in this way to embark in a very heavy expenditure, and much larger than they anticipated at the period these trials were instituted, and I know there were some members of the Finance Committee who were very much concerned about the financial condition of the trust, and I remember perfectly that they had under their consideration the expediency of limiting their operations until they saw their way a little more clearly, as to their means of meeting these engagements. I do recollect that I attended several meetings of the Committee, where these

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things were discussed in 1842, and Mr. Spreull being treasurer, and present at these meetings, I think he is extremely likely to have received some hint from the Committee, that the expenditure must be reduced as much as possible, and that this writing must have emanated from some motive of that kind on the part of the Committee, by way of seeing that the trustees did not exceed the amount of their pecuniary resources. I believe that memorandum must have been handed to Mr. Bald, in consequence of a desire on the part of the Committee to proceed prudently in the execution of the works.

669. The object of my question was to ascertain whether any Minutes were entered by the Committee of Management or Board, directing Mr. Bald to proceed to improve the river at any particular spot?—There may be Minutes in special cases; Mr. Bald did not always receive his instructions in writing; in cases of magnitude, I think it is probable he received his instructions in writing.

670. Have any of his reports respecting improvements for the upper part of the river especially been received? Do you recollect the Report made by him recommending improvements above the bridges?—I think there are several.

671. Do you recollect any Minutes, or any measures taken in consequence of them, to carry them out?—I do not think it was in consequence exactly of Mr. Bald's reports. He did report upon these operations, but I do not recollect any single improvement suggested by Mr. Bald, taking place without its having been approved of directly or indirectly by Mr. Walker. I cannot trust my memory to state that any of these reports were adopted by the trustees.

672. You say without being referred to Mr. Walker,—within these six years, after the plan was drawn by Mr. Walker for the improvement of the Clyde which Mr. Bald was to carry out as executive officer; how often have you consulted Mr. Walker?—I could not trust my memory in stating how often.

673. Have you ever once consulted him?—Yes; Mr. Walker was consulted within the last three or four months about the erection of walls.

674. (To Mr. *Walker.*) Since you gave Mr. Bald the plan upon which his operations were to be founded, how often have you been consulted by the trustees as to further improvements?—Frequently as to improvements, but not as to the particular mode of carrying out what may be called my plan. But when I say "my plan," I am presuming too much, because it is due to an individual (Mr. Logan) who is now dead, to say that he had projected the lines of improvement before I was consulted by the trustees. I modified Mr. Logan's lines: I came to Parliament with those. After that the trustees, without Mr. Bald, considered that the lines might be abridged within what I had proposed. I went down on one or two occasions, and arranged the whole plan with Mr. Bald, and since that time, the particular deepening I have not been consulted about at all. I believe Mr. Bald acted under the immediate direction of the trustees, but the trustees, in order to save expense, have not called on me, but in all their improvements upwards which had not been defined I have always been consulted.

675. Is it your opinion that towards improving the Clyde all impediments to the flow of the tide upwards should be removed as much as possible?—Certainly not as to width, because to remove impediments to the width would be to bring the river back to what it was before the improvements were begun at all. Perhaps the Commissioners are aware, and in fact it is now almost proverbial, that there is no river in, perhaps, I may say the world, that has been so much improved as the river Clyde has been; that when the greatest man of his day, Smeaton, was employed, there were only some three or four feet at the high water of a neap tide at Glasgow; that by following the directions of Rennie and Golborne, and afterwards Telford, which was to contract the river and to remove the shoals and then to trust to the freshes of the river deepening the channel of the river, confining it in width, that in that way the navigation would be improved. That is the great principle that has been adopted in the improvement of the Clyde, and it has been done with very great success; therefore to remove the banks and allow the tide to have its full range up again, would be to undo all that has been done. The river would naturally come back again to its former state. That would be the tendency, but I think that the perfection of the river Clyde is this, that a deep channel is formed because the channel is uniformly narrow. It does appear to me that the river was made too narrow, that Mr. Telford's advice on that was to narrow it beyond what afterwards appeared to be beneficial; but that, like many other things, is done by degrees. If the river Clyde had been made at first as wide as the trustees now propose to make it, the depth of water would not have been obtained, and the trade would not have come up the river which has enabled them now to find a revenue and to widen it again, because it will not support its present width without an annual expenditure in artificial deepening. When it was so narrow, it did nearly support itself, but I have told the trustees that by this widening which I have recommended to be done, they must expect a considerable expense in artificial deepening.

676. (Mr. *Godson.*) How much wider is the new widening?—I dare say the navigation will be double what it was before. I have made it as wide as I think the size of vessels require, and yet made it so narrow as to endeavour to make the tide and the freshes keep the river clear with small assistance. When I say the tide and the freshes, I refer to the lower part of the river. I have already said that the upper part of the river is the effect of the freshes only, and I have said in my report that all the dykes in the lower part of the river ought to be made only half-tide dykes so as to allow the tidal water to come up freely, but that in the upper part of the river the tide is of no consequence.

677. (Mr. *Hume.*) Have not part of the improvements in the river been obtained by removing projecting points in the course of the dykes on each side because they protruded into the stream?—Yes.

678. Are we to understand that you do not object to the removal of those portions of the

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dike that project and impede the flow of the tide, provided the width which you have considered necessary is maintained?—Yes.

679. During the last six years have not a great many of those projecting points which did give a direction and interfere with the tide, been removed?—Yes, and the river widened. I am speaking now from information; I had not visited the lower part of the Clyde professionally.

680. Are we to understand from you that you consider the improvements to have taken place mainly by dredging, removing banks, and taking away projecting points of the shore on each side that impeded the tide?—Yes, and narrowing the current of the river.

681. At the lower part?—All the way up.

682. Narrowing thereby to increase the current at these spots where it is shallow?—Yes, to increase the current within the part so narrow.

683. And deepening the channel in those parts?—Yes, but I am quite sure that somewhere in the records of the trustees, my opinion will be found, with regard to Newshot Island; and I at once say that I think it would have been, and will be almost a waste of public money, to endeavour to stop up the present channel on the north side, and to make it to the south of the Newshot Island. I say waste of money, because the money required for it in the removal of the stone quarry in the channel would be very considerable.

684. Do you consider that would be the principal objection to opening the southern channel? —The cost of removing the solid stone rock under low water, the deepening of the channel from end to end, and stopping up the northern channel; and there is a length of two miles of property abutting on the present channel of the river, which would have to be stopped up. The owner of that property would, I conceive, have a claim to heavy damages, if the trustees were to take the river entirely away from his property, and give it to the property on the south side.

685. Would not the southern channel if deepened, be a more direct channel for the navigation than the north now is?—It would be somewhat; I think it would be about 130 yards shorter in a length of two miles. I really could not recommend the trustees; I did not consider the merit of the south side to be such as to induce me to recommend the trustees to stop up that channel which Mr. Smeaton, and Mr. Rennie, and Mr. Telford considered the best, and Logan also, and to substitute the southern channel for it, and the northern channel was approved by the Committee according to the plan at the time the Bill was in Parliament in 1840; but I would ask any one to say whether the difference is such as to justify my recommending a very heavy expenditure.

686. You would consider it necessary to ascertain first what the absolute expense would be before you could advise it?—Yes, and I think I did, and I am now prepared to say that the expense would much exceed the public benefit, and the trustees would not have been justified in attempting it. If the section of the south channel made by Mr. Aird be correct, which I have no reason to doubt, the removal of the solid stone rock for half a mile in length, in order to give a sufficient depth, would cost ten times what Mr. Bald estimated for all the work of opening the south channel.

687. (*Capt. Washington.*) Without making the southern channel a navigable channel, would it not be beneficial to take down so much of the parallel dike as would allow the tide to ebb and flow through it?—I do not remember what the level of the parallel dike is, but if the question refers to taking it down, so as to allow the water to ebb freely up and down through it, then I do not agree with it, because as will be seen in a moment, if you allow the tide to ebb freely through the two channels, you divide the power and diminish the water.

688. Suppose the dikes to be half tide or quarter tide by which you would secure in the one case the flow and have the benefit of the entire scour, and at the same time keep the half and quarter of the ebb in the proper channel, would not that be beneficial?—Yes, and I rather think that is so.

689. Are you able to state what your views are as to the possibility of further improvements, so as to deepen the water up to the quay at Glasgow to any extent?—I can only refer the Commissioners to the evidence I gave at great length, and which is printed, and to my report in 1837, and also in 1840, which were transmitted to the Commissioners from Glasgow.

690. I am alluding now to the improvements that have been made in the last few years; after these improvements, I ask whether any thing further can be carried on?—I am not aware of any, if the trustees with Mr. Bald have been carrying on the improvements according to the plans that were agreed to by me some years since.

691. Is there a longitudinal section of the river Clyde from Glasgow to its mouth?—Yes. I would state that while I have been speaking Capt. Beaufort has been trying the difference between the north and south side of Newshot Island, and he states to me it is only 87 yards, in place of 130 yards which I named.

692. (Mr. *Hume* to Mr. *Gray.*) Why is the Glasgow Bridge Bill proposed to be recommitted to day?—Some petitioners against it were not heard in Committee.

693. Do you intend to pay any money from the Clyde towards that bridge, because in the 48th clause it says that the Trustees are to give over above 8000*l*. How is that at all connected with the navigation?—It is proposed under other clauses of the Bill that the navigation shall pay a certain sum towards the erection of the bridge, in consideration of the piers of the bridge being sufficiently deep to enable the trustees to carry on the improvements which they have at present power from Parliament up as far as the Stockwell-street Bridge, and with a view of prospective improvements above it.

694. Why should the trustees pay any portion of that which is intended for improving the navigation?—Returning to the advice under which the trustees have all along acted, Mr. Walker reported as to these three bridges, in the month of September, 1844. He says—"While the weir existed at the Glasgow Bridge, the Stockwell Bridge piers were compara-

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tively secure; but the removal of the Glasgow Bridge weir has rendered the sand which formed the bed of the river up to the Stockwell-street weir liable to be washed into the deep pool (the Harbour) below the Glasgow bridge, even if there had been no artificial deepening done to form the upper harbour; and this deepening is in progress." It is the opinion of Mr. Walker that the deepening cannot go on until the piers of the new bridge are founded much more deep than the old one. The old bridge will fall if the deepening is carried on, and the river trustees deem it a fair and just arrangement between the two trustees that the river trustees should pay the additional expense incurred by founding the piers of the bridge sufficiently deep for this purpose, and also the expense of removing the weir from the Stockwell-street Bridge to the distance of 140 yards above the Hutchinson Bridge.

695. Were not the foundations of that bridge strengthened a few years ago at a considerable expense?—In some degree they were strengthened.—(Mr. *Walker.*) The weir at Stockwell-street Bridge was strengthened under Sir John Macneil's and my direction. The principal object of it was a complaint from the water company that it was getting too low, and allowing them to lose their supply of water. It was simply done by driving a row of piles across the river, and that was done under the order of the Court of Session. It was referred to us in consequence of a complaint of the loss of water from the water company, we reported our opinion, and we were ordered by the Court of Session to execute this work: that was done. The great object of it was to keep up the head of water for the water company; but the weir also was strengthened, in consequence of the wash of water being so great that the piers were in danger. I would add, that Sir John Macneil and myself reported 8100*l.* as a fair sum to be paid by the Clyde Trustees to the Bridge Trustees.

696. That they might have an opportunity of improving the navigation?—Yes.

697. (To Mr. *Gray.*) Can you give us a copy of that order of the Court of Session, directing that they were to be run across the harbour?—No doubt it can be furnished by Mr. Turner (who had been obliged sometime previously to this to leave).

[*The Witnesses withdrew.*]

Mr. *Richard Hinde*, } Lancaster Quay Commissioners,
Mr. *William Robinson*, } examined.

Mr. *R. Hinde* and Mr. *W. Robinson.*

698. (*Chairman.*) (To Mr. *Hinde.*) You are one of the Quay Commissioners at Lancaster?—I am.

699. Are you authorized by the Commissioners to appear in their behalf?—I am.

700. Are you a party consenting to the contract with the Railroad Company?—I am.

701. Will you lodge a copy of the agreement with the Commission?—I will.

702. (Mr. *Hume.*) How far below the lowest existing bridge do you propose to have the new bridge?—500 yards.

703. How is that space occupied at present?—By wharfs and warehouses.

704. What depth of water is there at these wharfs?—Not above 2 or 3 feet.

705. What accommodation is there as a port to the town between the site of the proposed bridge and the nearest existing bridge?—The quay comes much below the old bridge, and continues below where the intended crossing by the railway now is.

706. For the landing of goods?—Yes; a considerable portion of that is used. The lower portion is not often used for the landing of goods.

707. What kind of bridge is that to be?—Two arches.

708. To admit of vessels passing under it?—The level we have consented to take is 32 feet above the level of the quay. It will not allow vessels to pass up.

709. (*Capt. Washington.*) What compensation will the Railway Company give for the quarter of a mile of harbour they are about to take towards improving the navigation of the river?—The amount agreed on is 16,500*l.*

710. Upon what estimate is that founded?—Upon an estimate taken for the compensation of the owners of quay property held under a lease, who will receive an amount of injury by depriving them of it, and in the construction of the quay.

711. How much of that money will go to improve the navigation?—None. The original demand was 25,000*l.* for the express object of leaving a margin for the improvement of the navigation, but which the Railway Company would not agree to.

712. (*Capt. Beaufort.*) What was the general intention of the improvements proposed? What did they intend to do to improve the navigation?—Taking off shoals so as to make the river straight to a certain extent.

713. What do they intend to do with the 16,000*l.*?—It will all go in compensation to the private holders of property and to the construction of a quay.

714. What will the quay cost?—Perhaps from 7000*l.* to 10,000*l.*; but I am speaking at random, for I do not recollect the estimates.

715. Will the gas works have to be removed?—We conceive not.

716. (Mr. *Godson.*) When the new quay is built, as your Quay Commissioners propose it, will that new quay afford the inhabitants of Lancaster as much accommodation as the present quay does?—I should think it would.

717. Lower down the river there is at present a quay called the New Quay. I wish to know whether the quay you are about to build under the Act of Parliament will or not be more commodious than that quay that you have got lower down the river?—Very much more commodious.

718. Looking to the navigation of the river, in your opinion, as one of the Quay Commis-

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sioners and conservators of the river, would the coming of the railway be any injury to the river?—No; not on the compensation.

719. Your compensation being for the interest of private parties; does the passage of the railway cause any impediment to the navigation of the river, being a less navigable river than it was before for the general purposes of the town?—The height of the bridge does not allow vessels to go under it, and impedes the navigation.

720. Does the impediment of it for 500 yards do any damage to the town?—It does to the property immediately concerned.

721. And that you gave money to?—Yes.

722. After you have paid your compensation, is it any injury to any one?—Except to the corporation, who have a right to have vessels higher up.

723. Have the corporation agreed to it?—I believe they have agreed to it; I am not prepared to say.

724. (To Mr. *Robinson.*) Do you know whether the corporation have agreed?—They have.

725. (*Capt. Beaufort*) (To Mr. *Hinde.*) Is there any reason why the railway should not be carried up on a sufficient level to allow a vessel to pass under it?—I see no reason but the expense.

726. Will not that expense fall on the railway company, and not the corporation?—It would.

727. What is the tonnage of the vessels that come up?—From 80 to 100 or 150 tons; and occasionally 200 and 250 tons.

728. If the railway company were obliged to make their bridge sufficiently high and sufficiently large in the arches to permit larger vessels to go up, that would be a great advantage to the trade, would it not?—It would.

[*The Witnesses withdrew.*]

Adjourned till Friday next, at 1 o'clock.

Friday, May 9th, 1845.

Present:—

Rear Admiral BOWLES, C.B., in the Chair.

Captain Sir Gordon Bremer, K.C.B.
Mr. Hume, M.P.
Mr. A. Chapman, M.P.
Mr. Godson, M.P.
Captain Beaufort, R.N.
Captain Washington, R.N.

Mr. *Wm. Robinson* and Mr. *Edmund Sharpe.*

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Mr. *William Robinson,* and Mr. *Edmund Sharpe,* } Lancaster Quay Commissioners, sworn and examined.

729. (*Chairman.*) (To Mr. *Robinson.*) You are acquainted with the two proposed railways?—I am.

730. Which do you consider will interfere least with the navigation of the river?—The line as originally proposed above the town, would interfere least with the navigation of the river.

731. How high do vessels come up at present?—Nearly to the ruins of the old bridge; they come up to what is called Lawson's Wharf, where they discharge.

732. (Mr. *Godson.*) How many arches has the new bridge?—Five arches.

733. (Mr. *Hume.*) How high does the tide flow beyond the town?—Up to Skirton Locks.

734. What is the distance from the east end of the town to the locks?—A quarter of a mile.

735. Is that quarter of a mile navigated by any sized vessels?—None; they cannot possibly pass the new bridge.

736. What is the opposition of the new bridge?—The lowness of the arches, and the want of depth of water.

737. The tide flows up through these arches up to the locks?—Yes.

738. When were the locks built?—Not in the memory of man.

739. Does the water at all flow over the locks?—I think the tide very seldom if ever flows over the locks; it does not always reach it.

740. Then these locks have stopped the flow of the tide that would otherwise have run up the river?—Yes.

741. (*Chairman.*) Then if the new line of railway should be approved, the new quays and wharfs must be built below it?—They must.

742. (Mr. *Hume.*) From the ruins of the old bridge to the intended line, what extent of harbour will be interfered with?—I should think about 500 yards.

743. What sized vessels come to that harbour now?—At present there are various sizes; vessels varying from 80 tons to 100 and 150 tons, can navigate that portion of the river.

744. Has any effort been made of late years to deepen the Lune River by dredging or any other means?—There has; at Scale Ford efforts were made some years ago.

745. Are you aware that the Quay Commissioners gave their consent to the new line?—I am; I was one of the committee.

746. Has there been another Board elected since the 2nd of May?—There was one elected on Wednesday last.

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747. Has that Board come to any resolution respecting this bridge?—I have not heard of any.

748. Have the new Commissioners given any fresh orders?—I am not aware of any; they are elected every three years, and Wednesday was the day appointed by the Act of Parliament. Mr. Sharpe can speak to the election, but there has been no confirmation of this agreement.—(Mr. *Sharpe.*) I know the names of the Commissioners who have been appointed; we have no further communication with them.

749. (To Mr. *Robinson.*) You were two of the old Commissioners?—Yes, and also two of the present Commissioners.

750. (*Capt. Beaufort.*) Have the new Commissioners met since their appointment?—I apprehend not.

751. (*Capt. Sir G. Bremer.*) You, as members of the former Commission, have consented to the new line?—Yes.

752. (*Chairman.*) Will you state a reason for so consenting?—We consider the railway passing in that direction would be more likely to be beneficial to the navigation and the town at large, than by passing in the old line as connecting the railway and the navigation nearer together.

753. (Mr. *Hume.*) Do you take into account that it would stop the flow of water upwards, and might interfere with the depth of the navigation below?—The whole of that question was considered, and the probability of benefiting both the river and the railway.

754. In what way would the river be benefited, if the flow of the tide upwards was impeded by that new arrangement?—It could only be impeded by the piers of the bridge.

755. (Mr. *Godson.*) Is more than one pier to be in the river?—Two piers in the river.

756. (Mr. *Hume.*) What proportion of the water-way would those piers be, taking not only the middle but the side piers?—(Mr. *Sharpe.*) Twenty-four feet.

757. (Mr. *Godson.*) (To Mr. *Robinson.*) Have the inhabitants of the town of Lancaster held any public meeting respecting the crossing of the river, have they come to any resolution whether they approved or disapproved of it?—There was a large meeting, and a resolution passed approving of the new line by the inhabitants generally.

758. Was it a meeting called by the mayor, or was it a common meeting?—A requisition was presented to the mayor, and he appointed the meeting in the ordinary way

759. Was it numerously attended?—Very much so.

760. (*Chairman.*) In what way do you propose to compensate for the impediment that is thrown in the way of the navigation of the river, by preventing vessels coming, as they have hitherto done, up to the town and alongside the existing quays?—By erecting new quays to the westward of the intended viaduct.

761. (Mr. *Godson.*) Would that be done by you as Quay Commissioners?—Yes.

762. (Mr. *Hume.*) Does the Company's railroad propose any means by which the river shall be deepened?—I am not aware of any.

763. (Mr. *Godson.*) Was any portion of the 16,500*l.*, that is to be paid to you as Quay Commissioners, to be laid out in the improvement of the water-way of the river?—After first paying the compensation to the owners of property, and erecting the new quays, any surplus there may be will be applied to the improvement of the river.

764. Do you expect any surplus?—That is so uncertain that I am unable to state. I do not know what juries may give if parties apply to juries.

765. (*Chairman.*) You have no certainty of any surplus?—No.

766. (Mr. *Godson.*) (To Mr. *Sharpe.*) I believe you are an architect?—Yes; and the bridge master of the county.

767. Being an architect and bridge master of the county, will you explain to the Commissioners what will be the effect, either for good or for evil, on the River Lune of this deviation?—I am of opinion that the Railway Bridge will certainly be prejudicial to the navigation.

768. (Mr. *Hume.*) In what way and to what extent prejudicial?—In the first place, in regard to the flow of the tide unquestionably; and secondly, in the circumstance of its cutting off all communication with the present wharfs, quays, and warehouses.

769. (Mr. *Godson.*) Leave out the wharfs and quays, and assume, for the purpose of the inquiry as to the river-way itself, that new quays and new wharfs are erected by the 16,500*l.*, we want to know what effect it will have on the water way?—It will have a prejudicial effect; the extent of that prejudicial effect it would be difficult to state.

770. (Mr. *Hume.*) Is there any mode by which, in your opinion, the injury which the new bridge would do to the navigation might be compensated?—By deepening the channel below.

771. To what extent do you consider the channel might be deepened from the bridge downwards?—The whole length of the channel is 6 miles. The bed of the river at that bridge is 10 feet above low-water mark. Any improvement, therefore, of the channel, must necessarily be a very considerable one, and attended with very considerable expense.

772. Has any estimate been made of what the expense would be to deepen it from the mouth up to the bridge?—Yes; a report has been given in, and printed, by Mr. David Stevenson, the engineer.

773. What is the purport of that report?—It recommends the removal of shoals in different parts of the river to a specific depth. I would state incidentally that this report of Mr. Stevenson, and the measures he recommended, were not carried out by the Commissioners. It was considered too great an expense, and the improvement of too uncertain a nature to be undertaken.

774. What Commissioners do you allude to?—The old Commissioners.

775. What is the date?—The date of this report is the 14th of December, 1838. No measures have been taken upon that.

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776. Tell us what his recommendations were?—To deepen the river. I am unable to tell you to what extent, but I think to an additional depth of four feet in the whole course of the river. I speak rather uncertainly on that point, but the total expense to be incurred for that purpose is 13,200*l.*

777. What depth would that have given you at the new bridge now, at the site of the bridge proposed to be erected, if it were carried out?—A total depth of 16 feet at high-water of ordinary spring tides.

778. What is your highest depth now at spring tides?—I think about 12 feet, but I speak with uncertainty upon that point.

779. Would that depth which is contemplated suit the commerce of the district?—To a very limited extent.

780. What further depth do you contemplate the commerce of the district would require?—At least an ordinary depth of 20 feet at ordinary spring tides.

781. (Mr. *Godson.*) Is it possible to have more than 20 feet up at the new bridge?—I do not believe that the present river is capable of improvement to that extent, because the expense would be so enormous. It is right to state that other measures have been contemplated by the Commission.

782. (Mr. *Hume.*) In preference to deepening the whole channel?—Yes.

783. Has there been any report of any engineer to that purport?—No report has been made, or any expense incurred, or any measure taken with reference to them in consequence of the hope of the Commissioners that they would be able to derive important and valuable information from the Admiralty as soon as they became possessed of the plans that Captain Denham has been preparing of the bay and of the river, and they considered it therefore right to suspend any operations.

784. There has not been a complete survey taken for many years?—No. This survey has had the effect of satisfying many of the Commissioners that the improvement of the present navigation is hopeless to the extent that is necessary.

785. (*Capt. Washington.*) Without Sunderland Point is there any impediment in the navigation to the entrance of the river?—The whole of the outer navigation from Sunderland Point to the actual mouth of the river is so full of difficulty in consequence of the large extent of sand on each side, without any means of protecting the channel, that I apprehend the construction of any works to maintain the channel in that portion of its length would be infinitely more expensive than anything we should have to incur for the whole remaining eight or nine miles within the mouth of the river.

786. (*Chairman.*) Has there been any plan in contemplation for improving the navigation?—Yes; fifty years ago the merchants of Lancaster projected a deviation of the course of the river Lune from the Island Salt Area through the peninsula of land, which lies between Morecambe Bay and the Island Salt Area, westward near the old mill.

787. (Mr. *Godson.*) What distance is that?—Two miles and a half in length.

788. Is the country flat or hilly?—The whole of the country lying between the two points is, with perhaps one exception of 100 or 200 yards, scarcely above the level of high water mark at high spring tides.

789. (Mr. *Hume.*) Into what depth of water will you come in?—Twenty-four feet at low water.

790. If that new plan down to Poulton Ring, which you have stated could be carried out, would the benefit of the navigation up to Lancaster be such as to compensate fully any impediment that the bridge by the new railroad would throw?—It would more than compensate for it. At the same time, it depends upon how the question is put as to how it is to be answered, because, if the whole course of the river were to be blocked up, and the whole of the river diverted into this new channel, there could be no question that it would be most ample compensation; but if the whole course of the river be maintained, and the difficulties of diverting it be found very great, both in regard to compensation for rights and privileges, and in a nautical point of view; if those are to be taken into account, it is impossible to say how far the demand might not exceed in money the advantage to be derived to the town. Probably 100,000*l.* might be required for the works, and in addition to that, a very large compensation amounting to 20,000*l.*, or more to the land owners and for severance.

791. (*Chairman.*) Do you mean to be understood now as speaking of the compensation to the parties whose lands you would take and cut through?—Yes; before coming to a determination on the project which I have mentioned, the Commissioners would be guided by the information, that Captain Denham or the Admiralty may supply. The other project was not to divert the river but to bring this admirable sea channel into immediate communication with Lancaster by means of a railway and docks constructed at Poulton.

792. (Mr. *Godson.*) Would the new line assist in that project of having quays at Poulton, and thus assist the town of Lancaster?—I cannot conceive that it would have any effect upon it.

793. (*Capt. Beaufort.*) Are those docks at Glasson used at all now?—Yes.

794. By whom?—By the whole of that portion of the shipping which is unable to get up to Lancaster.

795. Who do the docks belong to?—To the Lancaster Quay Commissioners, they were constructed by them.

796. (Mr. *Godson.*) Have you a place for landing called the New Quay?—Yes.

797. Is that a place for landing goods and where ships stop when they cannot get to the town?—Yes.

798. (*Capt. Beaufort.*) What is the communication you have now between the Glasson docks and the town of Lancaster?—Not only do we make use of that harbour of Glasson, but the Lancaster and Preston Canal Company have a branch from that harbour to their main line from Preston to Lancaster, and a very large quantity of goods are brought on that

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canal up to the town of Lancaster to the north and down to the town of Preston to the south.

799. (Mr. *Hume.*) What class of vessels came to Glasson?—All vessels upwards of 100 or 150 tons burthen.

800. What is the largest vessel that comes there?—North American timber ships.

801. What is the largest that has ever gone into Glasson?—I cannot answer the question.

802. (Mr. *Godson.*) What is the largest that has come up to Lancaster?—Not more than 280 tons.

803. Was this branch down to Glasson originally made to the canal, or was it a branch made to accommodate the town of Lancaster; was it a part of the canal, or has it been made of late years?—It has been made of late years.

804. Was it for the purpose of bringing goods that had come from ships that could not get further up the river to the town of Lancaster; you unship at Glasson, and then come by the canal up to the town?—Yes, both to the town of Lancaster and the town of Preston. The traffic to the town of Preston, I fancy, is considerably more than that which comes to the town of Lancaster.

805. Does that come in through Glasson?—Yes.

806. Then the branch canal was made for the double purpose of coming to Preston and bringing the goods up to Lancaster that could not come by ship?—Yes.

807. For instance, if a 400 tons vessel came to Glasson and could not come further up she unloaded, and then the goods came by the canal?—Yes.

808. (Mr. *Hume.*) If the river Lune was deepened agreeable to the estimate, four feet at least all the way up, would that bring the goods that are principally required at Lancaster by the river?—Before answering that question it is proper to state that we anticipate a very considerable increase of our traffic; that a line of railway is projected to the town of Lancaster, which will be brought into immediate connexion with our port; that that line of railway will enable us to deliver the whole of the produce required in the West Riding of Yorkshire, at one half the price of tonnage charged at the present time from all other ports of Lancashire. Therefore, in order to answer the question properly, I should state, that with that expectation of traffic, I am quite certain that nothing like that additional accommodation would answer the purposes of the port.

809. (Mr. *Godson.*) Do you mean four feet?—Yes.

810. (Mr. *Hume.*) Looking at the present existing traffic between Lancaster and the sea, would that additional depth of four feet be sufficient?—I should be inclined to doubt it.

811. (*Capt. Washington.*) What was the original sum demanded by the Quay Commissioners, as compensation of the Railway Company?—25,000*l.*

812. Was any portion of that intended as compensation, with a view of deepening the navigation?—Decidedly.

813. How much?—10,000*l.*

814. (Mr. *Hume.*) Were you a party to that estimate?—I was.

815. Do you consider, then, that if 10,000*l.* was paid by the Railway Company, the injury which the new line would do to the navigation might be compensated by that 10,000*l.* in establishing dredging vessels, and otherwise clearing the shoals?—That is precisely my opinion; at the same time it is proper to state that the agreement has been definitively entered into with the Company by the Commissioners, against the voice of a minority of those Commissioners accepting 16,500*l.*

816. Has any protest been entered in the minutes of the Quay Commissioners against taking the reduced sum, instead of requiring the amount which was originally demanded, including the improvement of the river?—There has not.

817. What was the division?—I cannot remember.

818. Was there a considerable number?—I think there was only a small minority.

819. (*Capt. Sir G. Bremer.*) Did the Railway Company refuse to pay the 25,000*l.*?—They did. I may state that the public meeting called in Lancaster had a considerable influence on the Commissioners of the Quay, in coming to the determination to agree with the Railway Company for the sum of 16,500*l.*, which would simply put them in the same position in which they were before the railway came. The opinion of the minority was very strong, that that was not sufficient compensation for the injury that would be done to the navigation.

820. (*Capt. Washington.*) Are there any sailors among the Harbour Commissioners at Lancaster?—Yes.

821. How many?—I think a majority are either connected with shipping or actually owners of vessels.

822. (Mr. *Godson.*) When you state that 10,000*l.* would compensate for putting the bridge across, I want to know whether you mean that the bridge would cause an injury requiring 10,000*l.* to repair that injury, so as to leave the river as it is. Do you mean that 10,000*l.* would enable you not only to remove any injury that arises from the bridge, but to do other improvements that ought to have been done long ago?—The Commissioners consider (those whose opinions, in this respect, I represent) that, as the Railway Company would save something like 25,000*l.* to 30,000*l.*, the port was entitled to the whole of that saving by the deviations of the line, provided the sum, whatever it was, that exceeded the amount of compensation was laid out in the improvement of the river. The Commission is dissolved, and a new one has been appointed. We were sent here to represent the views of the old Commission. I believe those views will be found to be considerably changed; that they will be found to be a body desirous of carrying out any improvement which may be suggested by the Admiralty or other persons in authority; and I believe they agree with me in the feeling that, if according to the bargain at present existing between the Commissioners and the Railway Company, namely, 16,500*l.* should be paid by the Railway Company; and a further condition insisted on, that

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the bridge should be raised to such a height as to permit access to the present quays by vessels of 100 tons burthen, that would be found to suit all the purposes of the town, and entirely to satisfy the Quay Commissioners, and the best for the interest of the port.

823. (Mr. *Hume.*) Without any money whatever towards deepening the river?—Certainly. I consider that the whole of the 16,500*l.*, if the bridge be so raised as to permit access to the present quays, would be available for the improvement of the harbour.

824. Can the bridge be so raised, consistently with the level of the railway?—I conceive there is no difficulty.

825. (Mr. *Godson.*) For how much money?—From 5,000*l.* to 10,000*l.* in addition to the present cost.

826. (Mr. *Hume.*) In case of raising the bridge to admit of communication with the existing quays, and render new quays unnecessary, what height will be required?—I beg to refer the Commission to Captain Denham.

827. If the height of the bridge should be raised to that point which you have intimated, do you consider that the 16,500*l.*, as agreed on, would then be sufficient to clear out the navigation of the Lune, and render it navigable for vessels of 16 feet, up to the bridge?—It exceeds by 3,000*l.* the amount of Mr. Stevenson's estimate for doing it.

828. Consequently, you would consider that to be a fair margin to carry on the works?—Precisely.

829. (Mr. *Godson.*) Supposing the Railway Company to keep to their old line, and do not contribute a penny, have you any fund by which you can deepen the river yourselves?—Yes.

830. What do they arise from?—We have a debt of 4,100*l.*, but we have the tolls, &c., upon which we can borrow, probably, 30,000*l.* The Railway Company that I have spoken of, before, coming to the port, are anxious for improvements of the port, and would no doubt be ready to assist us.

831. (*Chairman.*) What is your average annual income from toll?—I speak with uncertainty on that point, but it is about 1200*l.* a-year.

832. (*Captain Sir G. Bremer.*) What is the railway to which you have just alluded?—The North Western Railway, which comes direct from the West Riding to the sea at the port of Lancaster.

833. (Mr. *Hume.*) Through that do you expect a great increase of tonnage to pass?—Yes.

834. (Mr. *Godson.*) Are you connected with that railway?—I am.

835. What are you?—I am the secretary of that railway, which was projected mainly with a view to the improvement of the port of Lancaster.

[*The Witnesses withdrew.*]

Mr. *John Swift*
and
Mr. *J. E. Errington.*

Mr. *John Swift*, Solicitor to the Lancaster and Carlisle Railway Company,
and
Mr. *John Edward Errington*, Civil Engineer,
sworn and examined.

[Major *Maclean*, Chairman of the Lancaster and Carlisle Railway, and *Henry Howard*, Esq., of Greystoke Castle, in Cumberland, were present.]

836. (*Chairman.*) (To Mr. *Swift.*) You are aware of all the circumstances connected with the proposed deviations from the original line of the railway?—I am.

837. The Commission is apprehensive that that new line will produce considerable impediment and injury to the navigation of the Lune?—That is, perhaps, very much an engineering question, upon which I may not be so well qualified to speak as others; but we were led to a contrary conclusion by an application from the town of Lancaster by a memorial which I hold in my hand, and in which the great advantage to Lancaster is represented very strongly, and the great disadvantage of constructing the line in the direction in which it was at first authorized.

838. The proposition came from the town of Lancaster to the Railway Company?—Certainly.

839. Then was there a proposition made from the town of Lancaster to the Railway Commissioners for compensation, by which they might be enabled to build new wharfs and also to deepen the channel?—Yes, that followed from the Quay Commissioners. The application was from the town to us, and that brought us into communication with the Quay Commissioners, and the Corporation and the Quay Commissioners asked for a sum of money; consequently an agreement was concluded for a sum of 16,500*l.*, a portion of which money was to be applied, as was stated to us, to the improvement of the river, and another portion to the restoring of wharfs below the new intended bridge, and to the compensation becoming due in that event to parties having property above the bridge. I should state that that memorial is signed, among other persons, by nine of the Quay Commissioners.

840. What date does that memorial bear?—Lancaster, 26th of June, 1844.

841. Signed by nine out of how many Commissioners?—Out of 16.

842. (*Captain Washington.*) You speak of the former Quay Commissioners?—Yes.

843. (*Chairman.*) The Quay Commissioners are elected triennially?—I believe they are. I hold in my hand a list of the names of the persons. I have no personal knowledge of their office as Commissioners; but this was given to us as containing a list of nine gentlemen who were Commissioners.

844. Did they sign it?—Yes, and a separate paper was given showing they were Commissioners. I should state that at the public meeting which was held before the agreement was concluded, which was largely attended, and a report of the proceedings of which I hold in my hand, many gentlemen attended also from Lancaster, and among others Mr. Greene, the member for the place, and he appears to have taken a part in the discussion in favour very

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Mr. *J. E. Errington.*

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much of the new line; and the letter appears to have been read at the meeting from Mr. Marton, the other member for the town, also approving of it.

845. (Mr. *Hume.*) In this memorial it is stated that the navigation will be improved by the new line. Was there any discussion, or has there been any specification in what way the navigation will be improved by the bridge being brought below the town, instead of above the town?—I think not. It was spoken of at that meeting, as for the promoting, carrying on, and effecting a design so beneficial for the town of Lancaster, and so conducive to the increase of trade and navigation and the good of the public. That is signed by Robert Greene Bradley, E. D. Salisbury, Thomas H. Higgins, John Lodge, William Jackson.

846. You have stated that the money to be possessed was to be employed in improving the navigation?—Partially.

847. What portion of the money to be so employed?—We never inquired.

848. Was any greater sum than 16,000*l.* required?—Originally more was asked.

849. Was any written application made to you, and did it state for what purpose the larger sum was wanted?—I have no recollection of a written application; verbal communications were made, but to none of which, to my knowledge, was any particular apportionment of the money mentioned.

850. What was the amount originally demanded?—I think 20,000*l.*; we were thinking of about half that sum, and ultimately we were induced to get up to 16,500*l.*

851. Were you, the Railway Company, willing to appropriate any portion, and what portion of that towards the improvement of the navigation?—I should not be dealing candidly if I affected to say we thought much about it; we considered it was a sum of money to be paid to the Commissioners, they stating that they meant to apply a portion of it to the improvement of the river, but we did not inquire what portion.

852. Is it not usual, on demanding compensation, to state for what objects that compensation is required, and as you have mentioned that it was for the improvement of the navigation, can you not state what portion of that compensation was demanded for that purpose?—I cannot.

853. If the Commission are satisfied that the navigation would be impeded by the erection of a bridge lower down in the new situation, is the Railway Company prepared to make any compensation to enable the navigation to be compensated by deepening, or otherwise for any injury received from your bridge?—We consider we have paid largely and liberally in the sum named.

854. If it shall appear that that sum which you agreed to give will scarcely be sufficient to compensate for those purposes, will you be prepared to afford any larger sum to deepen and improve the navigation?—We have never considered that question. Without consulting the directors I should not be prepared to give an answer, except that we consider we have already paid a very large sum.

855. Would there be any and what objection to raise the bridge, which is now 32 feet, to twice that?—That was discussed much with the Commissioners at the time. It was matter of great consideration and repeated interviews and discussions. I think the lower height was first agreed to, and we afterwards agreed to raise it to 32 feet, which was stated to be quite sufficient.

856. Was not that height considered sufficient when the proposition came of building quays below the bridge instead of using the quays above the bridge?—Certainly; but I fancy a height of 80 feet is impracticable, or any height greater than our present height.

857. (Mr. *Hume.*) (To Mr. *Errington.*) What is the objection to raise the bridge where it is to cross the Lune so high as to enable the vessels that now use the quays above that space to continue to use it?—I have no hesitation in saying we should never have entertained the project; that we should never have attempted to change our line, if we had contemplated such an expense as that would involve; from the position of the ground, and various other circumstances, it would be an enormous expense. I cannot state at this moment how much, but it would be all but impracticable as connected with our project, and the position in which our bridge was formerly placed.

858. (*Chairman.*) In the event of your being obliged to raise the bridge to the height of 70 feet instead of 32, I understand you would give up your new line altogether and prefer the old one?—Most assuredly; it is my opinion.

859. (Mr. *Hume.*) What amount of compensation would the railway be willing to give, leaving their other arrangements to be such as they please towards the improvement of the river; the deepening of the river from the bridge downwards to compensate for the impediment the bridge may give?—(Mr. *Swift.*) The fairest way to answer that is, supposing we had not been asked by the Quay Commissioners to give any specific sum to them, we should have been willing to pay the parties whom we were damaging, warehouses, for instance; and then to have considered what is the proper sum to contribute towards the improvement of the river.

860. What would that amount be?—The only sum ever spoken of to us was 2000*l.* or 3000*l.* for dredging the river, and something of that sort.

861. (Mr. *Godson.*) Supposing the agreement between you and the Quay Commissioners were set aside altogether, and that you had now to form a new agreement, that is, to compensate the people whose lands you had taken, how much would you then be prepared to give for putting down the two piers in the river?—That perhaps is matter for the Directors to consider, but I should have thought if they had been asked to give 2000*l.* or 3000*l.*, or 2500*l.* (we were never asked any sum), we should probably have been disposed to do that.

862. Supposing that agreement were set aside altogether are we then to understand that you estimate the damage you are doing to the river, by means of the two piers you put in, at 2500*l.*?—Yes, we have never thought of any other sum than that.

[*The Witnesses withdrew.*]

Adjourned till Wednesday, the 21st instant, at 10 o'clock.

Wednesday, 21*st May*, 1845.

Present:—

Captain Sir GORDON BREMER, K.C.B., in the Chair.

Mr. Hume, M.P.	Captain Beaufort, R.N.
Mr. Chapman, M.P.	Mr. Godson, M.P.
Mr. Airy, Astron. Royal.	Captain Washington, R.N.

Capt. H. M. Denham R.N., F.R.S.

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Captain H. M. Denham, R.N., F.R.S. examined.

863. (*Chairman.*) You are a Commander in the Royal Navy?—Yes.

864. How long have you been engaged in the surveying service?—Thirty years.

865. Will you state the parts of the coast of the United Kingdom that you have surveyed? —I assisted to survey the Channel Islands (Guernsey, Jersey, Alderney, &c.) I acted as chief assistant in the surveys of the English and St. George's Channels, from the straits of Dover to the edge of soundings; the coast of Ireland, from the Shannon to Belfast, including Beerhaven, Crookhaven, Valentia, Baltimore, Glandore, Cove of Cork (entrance), Youghal, Waterford, Carlingford, Strangford, Ardglass, Belfast, Copeland Isles, Larne; on the English coast, Falmouth (sound), Helford, Manacles (reef), St. Helen's Pool, Scilly Isles, Skerries, Start Bay, Salcombe, Plymouth Sound, Dartmouth. I have conducted the surveys of the Bristol Channels throughout, including Hartland Quay, Cloodly, Barnstaple Bar, Appledore, Ilfracombe, Minehead, Watchet, Bridgewater, Kingroad off the Avon, Cardiff, Newport, Chipston, Swansea, The Mumbles, Llanelly, Estuary of Bury, Carmarthen, Tenby, Milford Haven, Solvach, St. Bride's Bay, and Lundy Island; coasts of Lancashire and Cumberland, with the Dee (to Chester), Liverpool Bay, and Mersey; Morecambe Bay, including Fleetwood, Lancaster and Piel a foudra; The Duddon and Ravenglass Estuaries, Whitehaven, Workington, Harrington, Maryport, and Douglas, Isle of Man.

866. In your survey of the River Lune and Morecambe Bay, did you examine the river and bay with a view to the improvement of the port of Lancaster?—Not with that view, but to the general development of the bay.

867. Have you formed an opinion upon the subject?—Yes.

868. Will you state your opinion?—Taking the Lune in its present outfall, we trace it down a sea-reach, through sands of four miles depth, obliquely to the flood and ebb-tide sets. As soon as I found what really was the shallowness and tortuosity of that sea-reach channel, it struck me as a hopeless case the maintaining the exit of the River Lune in any course that it had hitherto taken to itself. While such was developing itself, I found (where the region was considered as blocked up by sands) a hitherto undefined retention of tidal water or arm of the Irish sea with very slight interruptions, none of them, with one trifling exception (Low Scare), rising nearer the surface at low water than 18 feet, reserving 20 to 30 feet depth at the Old Scare, called Poulton Ring, on the northern side of Heysham promontory. Since then my attention has been called to the possibility of reviving the trade of Lancaster, a project I have scrutinized, and there certainly is a capacity of water available at all hours of the tide with pretty nearly a straight course from Lune Deep.

869. In order to establish a harbour at Poulton Ring, you must cut a sea passage nearly north to communicate with Lancaster?—That is only supposing a water-borne transit in connexion with Lancaster desirable, but it does not follow that any of the river water is required to create or maintain such a port there. Railway connection might reasonably suffice, and it should be well weighed whether the diversion of the river water might not be mischievous in the formation of such harbour.

870. (Mr. *Hume.*) Do you propose to cut a new harbour at Poulton, and to carry that up to join the Lune at Lancaster, or do you intend to use the railroad?—All the purposes of a harbour, and ready tidal connection with Lancaster could be effected without interfering with the Lune at all.

871. What is the distance?—Two miles and three-quarters.

872. Will that bring you to Lancaster itself?—Not to Lancaster itself, but opposite the warehouses on the north side of the river, where the Carlisle railroad crosses the estuary.

873. You mean the one that is to cross below Lancaster?—Yes, a canal might be borrowed from the river for the purpose of transporting ships to the basins, which might be created upon the northern side of the present river. Whilst the transit of passengers and light goods by packets and coasters would take place by railroad in the easiest possible way, being so short a distance. For the purpose of passing ships nearer to the Lancaster warehouses, and putting them in any future basin on the north side of the river, the canal connection for ships might be desirable, and easily arranged. Turning the Lune altogether I do not see the desirability of, perhaps better that it should not, for the sake of the harbour that is to be formed, when we recollect the silt which it is charged with. The only inducement to turn the Lune would be the saving of all the land that the estuary now presents at low water. For the purpose of the new harbour, I would say that the desired breast-works being built on the Old Scare, there would be no assistance required, except a canal communication to feed a lock-basin, and transfer cargo by flats; and if found more desirable, to transport a ship with her cargo nearer the town than to unship it and pass it on by the railroad.

874. Do you consider the latter course for trade preferable to any endeavour to improve the navigation of the Lune as it now is?—Certainly.

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875. Have you examined the different parts of the Lune, descending from Lancaster to Glsson?—Minutely.

876. Is it in your opinion capable of being deepened so as to admit vessels drawing 16 feet water up to where the new bridge is to be?—Certainly, anywhere between Glasson dock or Sunderland Point and the new bridge or viaduct. It is quite within engineering practice of being deepened and straightened.

877. Have you formed any opinion as to the expense which would be incurred in removing the impediments, so as to deepen it to the extent stated?—I have not. It would be not merely deepening, but the greater part of the expense would be in forming directing walls and embankments to preserve it.

878. Have you formed any estimate of the expense of the connexion by canal from Poulton-le-Sands, southward, up to Lancaster?—I have a conjecture like 130,000*l.* to create the breast-works, basins, and canal connexion.

879. What would be the expense supposing no canal were formed, but the quays were made at Poulton and the conveyance left to the railroad?—About 100,000*l.* The greater part of the 130,000*l.* would be in constructing the breast-works, piers, which would be nearly half a mile in extent to embrace the whole rise of tide and the excavation necessary to form a tidal basin.

880. Do you mean a basin for vessels to lie in?—Yes.

881. In what depth of water then would vessels enter at Poulton?—Where the pier-head would be projected, a few yards only beyond the present low water mark, there would be 12 feet of water without any deepening. The excavation within would have to be wrought to a depth of 14 feet to attain a layer at low water level, but no deeper, on the eastern aspect of the breast works, an enclosed float should be formed with lock-gates, to avert the possibility of a mere tidal basin filling up again; vessels arriving at half-flood would lock into such basin and docks.

882. (*Chairman.*) With regard to the facilities of navigation are you of opinion if there was a harbour at Poulton and ready access from the sea, ships would be enabled to get up there, and the vessels might be discharged, avoiding the delays and sinuosities of the river Lune?—Yes. I may remark that I have known ships drawing 16 to 18 feet water, bound to Glasson dock, detained five and six days, waiting for the spring tides to lift them over the four-mile sea-reach and bar.

883. (*Capt. Beaufort.*) The whole of that opinion is formed upon the supposition that that harbour will remain?—Yes.

884. Have you compared your survey with the ancient charts, and found no great change has taken place in the extent of those sands?—The only reputed survey that I have heard of I caught a glimpse of to-day. I have not yet compared it side by side with my survey of 1844 now on the table, but I would say that, considering that survey was projected in the year 1826, only 19 years ago, it could not have represented the features of the banks at all at that time from the immense difference that appears.

885. From the reports of people on the spot have those sands advanced or not?—They have not. There has been a change of the Kent from what I now call the False Grange Channel. The Kent diverged to the southward in the year 1838, breaking through into what is now called the New Grange Channel, presenting the Victoria opening.

886. (Mr. *Hume.*) How high does the tide flow up the Kent river?—Within half a mile of Levens Bridge, beyond Milnthorpe.

887. How many miles is that from Poulton?—Twelve miles.

888. Is it navigable to that extent?—An occasional flat gropes up to Milnthorpe, *i. e.* Sand-side beach.

889. (*Capt. Beaufort.*) Is it intended to run an embankment across those sands?—I have heard so much of that that I have been careful to anticipate the queries that would arise in case such a matter came before Government, a question or proposition that may occur at any time. There is a great desire to inclose this bay, with the permission of Government, both to create a vast agricultural accession to the county, as well as for railroad communication between Lancashire and Cumberland.

890. If such a thing should ever be carried out, would it not altogether and entirely destroy the projected harbour at Poulton?—Perfectly; they are not compatible except by the Kent and Keer rivers being brought down that side of the bay and maintaining the harbour channel for a time.

891. What would be the effect of the second projected line?—Equally inimical.

892. (Mr. *Hume.*) Explain in what way that enclosure of the sand would affect and destroy the harbour?—I consider the present depth of water that is retained abreast of Poulton Ring, in connexion with Lune Deep, to depend entirely on the reflux of the vast body of tidal water taking place, as well as the pressure of that influx now required to fill the bay area.

893. What is the depth of water over those sands at high water springs?—Over the crown of Cartmell Wharf nine feet; following the section across on the western edge it is 13 feet; three miles further on it is nine feet; we then come to 13 feet below low water level in the channel; three miles further we come to 17 feet depth below high water level.

894. (Mr. *Hume.*) Have you made any calculation of the amount of tidal water to be excluded if the project was carried out?—57,000 acres.

895. Are the Board to understand that any inclosure of any portion of these sands would tend to lessen the depth of water in the bay?—Yes; the several deep pools, channels, and dykes, which are considered to be caused by the out-fall and dip and scour, would be choked in proportion.

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896. Is it your opinion that no inclosure of sand over the tidal water flow should be permitted with a view to preserving such channels as do exist?—As far as relates to the channel in connexion with the outer or broad waters, for I conceive that *they* depend on the quantity of tidal water that flows and returns; but inside I would embank all bights and sinuosities, and straighten the river course to render permanent the depths and channels once obtained, the which never can be attained or maintained while the water is allowed to go over it as a broad sheet expanding over a chance-shapened estuary, where the sands are diurnally buffeted about. I find that the river waters cannot course down permanent channels; whilst the tidal flow upsets whatever the river would do of itself if confined.

897. You consider that the reflux of the tide ought to be confined within such limits as would direct its velocity, and deepen its channel?—It would give the river the full advantage of preserving a water-course down, but when I come outside I consider so far as regards the maintenance of such gutter-ways which appear upon the plan, a great deal depends on how far that is charged with tidal water as well as the fresh. There is a distinction that occurs to me in that respect. I would wish to add, that where an eddy is formed in any portion of the river I would endeavour to cut off the cause of that eddy.

898. (Mr. *Airy.*) Could you rely on the permanency of a harbour at Poulton?—Giving the term a century to range over, I should say there is every chance of maintaining it. There has been from time immemorial navigable water off Poulton Ring; cruisers that were looking out for smugglers or to press men last war, took up anchorage there; but so little understood that it has never presented the refuge it might within the limits of the bay. There is not a buoy or beacon, or light to lead to it.

899. (*Chairman.*) How far back is your own knowledge of the nature of the anchorage off Poulton?—My local knowledge is confined to the past year, that I have been surveying that particular part.

900. (Mr. *Airy.*) What is the section of the land between Poulton Harbour and Lancaster?—In an engineering point of view it may be called a level, and very little above high water level.

901. (Mr. *Hume.*) From the attention you have given to the navigation up to Lancaster, if you had 10,000*l.* to expend, in what way would you expend that sum to do the greatest good to the navigation?—I should attempt to do nothing with such a sum, beyond lighting and buoying, and perching the present channels and shallows, that is as they now exist, the buoys, &c. being subservient to the changes which are constantly taking place.

902. (*Capt. Washington.*) Are you aware that an estimate has been made by the engineer, Mr. D. Stevenson, that 7000*l.* would be sufficient to enable the Lancaster people to have 16 feet water all the way up?—I was not aware of that, it is worthy of weight though, but certainly not my opinion.

903. (*Capt. Beaufort.*) What lights would you require?—I consider so much of the real access of the Lancaster navigation to depend upon such a point as Fisher Bank Patches, which dry at low water, extending three miles on a six-feet ridge, and covering a space of three miles by two, with not less than five and six fathom water at low water, so important as a breakwater. The knowledge of it, and the clearing of its spit would depend so much on being lighted, that I would put a floating light on the south-west spit of those Fisher Bank Patches. Then I would have tidal lights put on Sunderland and Chapel Points, or Abbey Scare.

904. Do you think vessels could go up there at night?—They now cannot possibly do so at high water, but they would then be enabled to obtain a position in Sunderland Hole, or proceed to Glasson Dock.

905. Before the channel was straightened as you suggested?—Yes, as the straightening process is only practicable above (within) Sunderland Hole.

906. (*Capt. Washington.*) Are the Commission to understand that if the passage were sufficiently lighted and buoyed, ships could run three or four miles up into a place of safety, which they cannot do now?—Yes, over the present four miles of bar (flats).

907. (Mr. *Hume.*) Are the arrangements for lights local or public?—Local. The St. George's Quay Company of Lancaster are the proprietors of the only light that pays general toll, which is called Walney Lighthouse. That light is imperfect in its action. Three or four buoys are placed in an irregular way, sometimes on one side of the channel, and sometimes on the other, and I should say if they ever have 10,000*l.* to lay out, the first expenditure should be in establishing elements to render that which exists more available than it is.

908. Under whose jurisdiction are those buoys?—The Quay Commissioners of Lancaster.

909. Who do they employ?—A buoy-master.

910. (*Capt. Washington.*) Do you consider the Quay Commissioners competent to look after buoying and lighting the channel leading up to the town of Lancaster, and for the coast trade?—I have no doubt of the efficiency of them in their trust and position, but I think that beyond the *high water* mouth of their own river, *local* trustees should have no control over the navigation in *any* case.

911. (Mr. *Hume.*) Then is it your opinion that the lighting and buoying of all parts beyond the high water mark should depend on the Trinity House, or some other public Board, and not on the Local Commissioners?—Certainly; my experience leads to that conclusion.

912. By whom was that lighthouse on Walney Island erected?—It was erected in 1789, under an Act of Parliament by the St. George's Quay Commissioners of Lancaster.

913. (*Capt. Washington.*) Is it a harbour light?—A channel and bay light.

914. (Mr. *Hume.*) Do you consider from the situation of that light on Walney Island, it ought to be considered a harbour light, or one of the general lights for the channel?—A general light for the channel, and every vessel coasting from Liverpool to the Solway depends on it. Every vessel coming into the bay pays, whether bound to Lancaster or not.

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915. What do you consider the limits of Morecambe Bay?—From Walney Point to Rossal Point.

916. Do vessels passing outside that point pay?—I understand so.

917. (*Chairman.*) You consider the light to be necessary and useful on Walney Island?—I consider it a most important light.

918. What is the nature of the Walney light?—A tower, 80 feet high, with three Argand lamps and reflectors revolving, obscured every five minutes, showing bright but one minute.

919. (Mr. *Airy.*) Are you able to state whether the navigation of the River Lune during the last 20 years has improved or deteriorated?—Deteriorated.

920. Are you able to point out in what manner, or from what reason that deterioration has taken place?—The connection between the mouth of the Lune at the high water orifice and the low water summit of tidal level has extended and silted so as to present a bar of 4 miles extent, and has dammed up a great deal of the out-fall of the scour, and instead of the last of the scour escaping to sea, or Lune Deep, as it used to do, it merely sweeps over the banks, which arrests its silt, that would otherwise have been carried out.

921. (Mr. *Hume.*) Would the employing of a dredging machine at the spot, to which you have alluded, tend to restore the river and improve the depth?—I should say that no dredging power would have any effect.

922. (*Capt. Beaufort.*) Did you not find very great benefit arise, and a very much cheaper system, in raking the entrance into Victoria Channel, at Liverpool?—Yes, by a system of harrowing.

923. Might not the same system be employed here with great benefit?—I think not, when comparing the two cases; the difference being in reference to the filling and discharge of that estuary down the long and wide Crosby Channel, and where I found that set impinging I harrowed to encourage it, and we got it over a mile of bar, which was impelled by the twenty miles of outfall. In the Lune, however, we have the four mile bar with a power of back water, which I consider quite inadequate to help permanently; besides the flood sets obliquely over the Sunderland shoulder and Cockerham sands. Whatever friction is effected then in the course of the two or three hours of ebb tide, is filled up by the cross set during the other nine hours.

924. You have an oblique traverse of tide?—Yes.

925. When the sands rise above the water and the water subsides into the channel, would you not then carry out what was retained, as well as out of the channel?—Yes, the last two hours of the ebb would scour.

926. (*Chairman.*) Explain the time that the sands are dry?—The upper part of Sunderland Shoulder, at a mile from the shore, are dried at one hour's ebb; at two miles two hours' ebb; at three miles dry at half ebb; and so on to the spit at low water.

927. (*Capt. Beaufort.*) If you were to begin at the outer part of the bar, and for the two last hours of every ebb rake up and disturb the bottom, would not two hours carry out the stuff to sea?—Undoubtedly it would; yet the nature of the sands right and left is such that I think it would fill up every space in the course of the succeeding tide.

928. (Mr. *Airy.*) Your opinion is, that the cause of the great injury of Lancaster navigation is the general extension of the sand?—Yes.

929. (Mr. *Hume.*) What is the rise and fall of the tide at the foot of Lune?—28 feet.

930. What is the height at Glasson?—24 feet upon equinoctial spring tide, 21 feet ordinary spring tides, and 12 feet at neap tides.

931. Do you know how high it rises at Lancaster?—At Lancaster Bridge we have 11 feet at high water ordinary springs.

932. What will be the depth of water between the present bridge and the intended viaduct?—14 to 17 feet at high water ordinary springs.

933. (Mr. *Chapman.*) What is it at low water?—6 and 7 feet water. With respect to the Lune I would add that the estuary is, like its sea reach, a maze of variable sands, without a light or any system of buoyage. The very sea-reach itself has but four black buoys to mark its four miles of vague course, and a perch to distinguish the Abbey Scare, which lies on the southern hand, abreast of which, and for three quarters of a mile above lies a 10 feet and 12 feet pool, called "Sunderland Hole," the best part of which, half a cable wide, is abreast and northward of the second perch. It would be impossible to offer any defined sailing directions where such a paucity of elements exist; no man can have any business above the first buoy at the foot of Lune, which is 11 miles below Lancaster Quay and 5 below Glasson Dock, without a pilot's knowledge, and there and then wait high water, or indeed a spring tide lift, if a voyager.

934. (Mr. *Hume.*) Did you make any representation to those Commissioners who have the charge of that navigation, as to the want of such buoys as you have now pointed out?—No, I considered it would be informal whilst preparing an Admiralty survey.

935. If the course of that estuary, and other estuaries which you have visited were placed under proper independent authority, do you consider that such navigations might long ago have been benefited?—Yes, I know to the disadvantage of such navigation, that persons undertaking to manage intricate seaward channels, is, that the chief of their trouble is with the toll-receivers, who are so reluctant to pay for the outer improvement. His constant fever is in vain endeavours to impress them, and relieve the exigency from the trammels of false economy; instead of a Board who would look only and promptly to the merits of his propositions, and decide on the outlay.

936. Then are the Board to understand that you think some competent authority ought to exist on the part of Government, to compel the proper application of any dues that might be raised with a view of supporting local harbours?—Certainly; it is the one thing needful.

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937. Have you observed the same neglect of improvement in navigation in other estuaries under other local authorities?—I have, particularly where the difficulties and anxieties lay seaward of the mouth of the river.

938. You are understood to say that wherever the approaches to an estuary extend beyond the land, it ought to be under a competent authority to direct an adequate number of buoys and other improvements that are requisite?—Yes.

939. In that case do you consider that the capabilities of the different harbours you have seen might be much improved?—I do.

940. Then is it your opinion that there should be an authority, like the Admiralty for example, with proper officers to superintend the coast of this kingdom, to see that the harbours were kept in the best possible order, instead of being left to the administration of interested and local bodies?—I do think it necessary.

941. (*Chairman.*) Do you consider that the inattention which you state has been shown with regard to this sea-reach, proceeds from a want of knowledge, or from a disinclination to appropriate certain funds?—I take it that the servants or persons employed to look after these things are held so completely from hand to mouth in their position, that they are afraid to press, and they do not get supported by the local authorities.

942. Do you think they have not the knowledge?—Local trustees rarely have enough knowledge, though the buoys may be entrusted to competent persons.

943. (Mr. *Airy.*) The great scour of the Victoria Channel, Liverpool, was undertaken by you?—It was.

944. Did you find any difficulty in carrying that measure?—So great and vexatious a difficulty, that the moment I had done it, I resigned the appointment of 700*l.* per annum.

945. (*Captain Beaufort.*) With respect to the Lune. Could no cheaper mode of directing the tide in its proper channel than the walls you spoke of be adopted?—I think not, where the tide rises 17 or 18 feet. The cheaper system of conducting water by weirs and cheverons could not apply.

946. (Mr. *Airy.*) Do you think a dredge would maintain itself?—No. My idea is, that the upper surface of every embankment should come above high water level three or four feet, if the approaches to these banks are under water at any time, they present, upon the slightest deviation of steerage in thick weather, under water ledges, on which vessels would hang and bilge.

947. (*Capt. Washington.*) Are you aware that the greater part of the embankments of the Clyde are half and quarter tide embankments?—Yes, but I have only considered them as being the foundations of progressive building.

948. On the contrary, the engineer recommends that all those be pulled down and half embankments marked out?—Then it must confine the stream to steam navigation, which can at most times command the course.

949. Will not dykes coming above high water, exclude the tidal waters which you have yourself stated it is a very great object to preserve in their full power?—In my opinion no part of the tidal water that goes into the Clyde would be of any use to the Clyde itself, but that as there are banks outside the high-water orifice off Greenock, there may be some jealousy about cutting off the tidal water that used to go up the Clyde, and those bars increasing for want of former back-water, and that is my first position, viz., that banks outside the high-water orifice require all the tidal water to help the scour, but I think it better for the sake of the part within, that dykes and embankments be brought above high-water level.

950. (Mr. *Hume.*) Have you not yourself stated an opinion that the last half of the tide-scour is important to keep the channel deep?—Yes.

951. Have you not stated also the advantage of allowing as great a flow of the tide upwards as possible?—For the sake of the outer bars.

952. Would not, therefore, half-tide dykes, while they permitted the full flow of water up, also direct the scour in the latter half of the ebb to the proper channel?—No; I do not perceive that the water thus descending would have any effect in keeping any particular course clear in that estuary.

953. Would there not, with a large quantity of water poured out by the ebb, be a better chance of carrying off the silt than if the quantity was limited, as you have stated, by walls? No, I think not, as respects the *interior* part of the estuary.

954. (*Capt. Washington.*) What would you recommend, under present circumstances, for the improvement of the port of Lancaster?—I would recommend abandoning the Lune to its present course, *in toto,* and making available the arm of tidal water that now exists up to the Poulton Ring, which will bring a ship or packet at *low water* spring tide within three miles of the town, instead of leaving her at an anchor for hours, and sometimes days, 11 miles from the town.

955. You mean by establishing a harbour at Poulton?—Yes.

956. Looking at the possibility of an embankment being run across Morecambe Bay, which would entirely destroy the projected harbour at Poulton, what would you recommend, under all the circumstances of the case, for the improvement of the port of Lancaster?—I would recommend that the present sea-reach over Sunderland and Cockram sands be assisted by more buoys, while all the interior part of the estuary should be straightened as much as possible by embankments for the defined outfall of the river Lune.

957. (*Capt. Beaufort.*)—Has any plan, to your knowledge, been made for the various lines that you have marked on your chart for embanking Morecambe Bay?—For the line A, D, on the plan—that is, from Poulton-le-Sands to Point Comfort—it has been considered and discussed in the Report of the Commissioners on Packet Communication with Ireland and Scotland.

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958. Do you consider it a feasible plan?—Yes.

959. What would be the general advantages of it in point of navigation?—I think the general advantage would be stopping the indraught to half its present extent into the bay, which at present exists and has been so fatal to the mariner.

960. Do you not consider such would be mischievous?—No. I think with reference to Ulverstone navigation up the Leven, that it has so languished from other causes that it is quite within the scope of the most reasonable compensation, and that the Kent navigation has also so diminished, that if it was not for the possibility of a harbour being formed at Poulton Ring to restore to Lancaster its shipping importance, then even the Lune and all below might admit that embankment for the sake of redeeming such a vast tract of land. The original idea was that it should be so constructed as to carry a railroad to connect the West Cumberland Railway, which, for want of it, is now diverging round over the Leven and Kent to connect Lancaster and Cumberland.

961. (Mr. *Hume.*) What would be the depth of water at that embankment at high water?—Varying between 41 and 9 feet.

962. (*Capt. Beaufort.*) At what average depth would the piles or other means you would adopt to make the embankment come to solid ground?—Nine or ten feet below the present surface.

963. Have you considered the causes that led to that singular phenomenon, the Lune Deep, which in one part suddenly jumps from 3 feet to 154 feet?—I have reason to believe that the mouth of this bay, which is eight miles from point to point, was not more originally than a mile and half in width. I find on either side of that original matter, not deposit, but such as must have been *terra firma*, where buildings and roots of trees are traced, and that Lune Deep was the channel into which the Lune poured, with all the other rivers, and that it is now filling up in proportion as the mouth of the bay has been widened; that all the subsoil has yielded gradually to the friction of the tide, and that its present existence is in a great measure ceasing, but it would fill up much sooner if the vast quantity of tidal water that rolls into the bay was intercepted. I do not consider the Lune Deep as it is traced and gauged in that remarkable dyke to be at all the result of tidal friction in the beginning, but that it is an original formation.

964. What reason have you to think that the Lune Deep is now filling up?—From the submarine tongues and spits which point at it from all the banks that are known to be increasing within it; for instance, Clarke's wharf; and I perceive, corresponding with that, a shelf is coming down gradually into the deep, and I have learned that the inner extreme of the deepest part of the deep is below the foot of Wyre water, whereas it used to be above it.

965. How much has it changed?—It is spoken of as having been up as far as the Lune buoy, say one mile.

966. What sort of embankment could be built from Poulton to the other side which would resist the action of the sea?—Proceeding on a piling frame, and depositing rubble stone, completing ledges of four feet high, returning and going on in layers of that sort with a proper bevel seaward, and that as these layers went on the tidal water would, from the time it rose just above the level till it came up to half-tide level, entrap the silt, and thereby add to and level the back deposit, presenting an amalgamation of silt, cement, and rubble stone, guided by and tied by the pile-framing, would faithfully resist the sea, no longer hurried on by an impetuous tidal indraught; no difficulty, in fact, in creating such an embankment as would be safe, and available for land enclosure, with sluice-gates for the freshes, and carrying a railway.

967. If that embankment was made, would not the tendency be to destroy the entrance of the Lune with all the harbours in the whole of Morecambe Bay?—I would certainly say that the three existing harbours or inlets, Lune, Wyre, or Piel, would not be interfered with.

[*The Witness withdrew.*]

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Mr. *John Macdonald*, Secretary to Arbroath Harbour Trust, } Sworn and examined.
Mr. *James Leslie*, of Dundee, Civil Engineer, }

[The Provost of Arbroath and Mr. Lindsay Carnegie were present.]

969. (*Chairman.*) (To Mr. *Macdonald.*) What is your situation?—Secretary to the Arbroath Harbour Trustees.

970. How long have you filled that situation?—Since 1839, when the Act was obtained constituting the Harbour Trust.

971. Was that an Act for the purpose of creating the harbour of Arbroath?—It was "an Act for extending, improving, regulating, and managing the harbour."

972. (Mr. *Hume.*) (To Mr. *Leslie.*) Since that Act passed what works have been erected, and what money has been expended on those works?—The old inner harbour was the only harbour then existing, and all the works outside have been constructed. The sea wall, quay walls, and the breakwater, set forth in the plan, have been erected in pursuance of the Act.

973. Do you mean that the large inner harbour has been entirely formed, and the breakwaters?—Yes.

974. How have these works been finished?—By contract.

975. (To Mr. *Macdonald.*) What has been the amount expended?—The amount expended in the works altogether, including the compensation to the town for the old harbour, is about 58,000*l.*

976. Have you power to borrow any more money?—No; the power we got to borrow was

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to an amount not exceeding 50,000*l.* We saved some money before the expenditure on the new works; we have exceeded our funds considerably, and we owe from 3,000*l.* to 4,000*l.* now, for which there is no present means of payment.

977. What depth of water has been obtained?—As yet no additional depth has been obtained. At present the depth of water is at ordinary spring tides from 11 to 12 feet only at high water.

978. In neap tides is the harbour dry?—In neap tides, when it is high water, it is 7 or 8 feet deep, and always at low water it is dry.

979. What further works are required to be done to make the harbour capable of admitting shipping, which the trade of the port can employ?—The estimate of Mr. Leslie is for an increased depth of 3 feet. The original plan was that it should be deepened from 5 to 6 feet; but if we had 3 feet additional depth of water it would answer the present purposes of the port.

980. (To Mr. *Leslie.*) To what extent does the proposed deepening extend from the outer heads?—233 yards.

981. (*Chairman.*) What depth of water do you get at the termination?—We propose to deepen down to low water of spring tides, and that will give about 17 feet at high water spring tides at the outside of the rock.

982. (Mr. *Hume.*) Is it dry at low water now to the extent you have stated?—Yes, of spring tides.

983. Have you to remove shingle or stone?—Boulder stones and soft freestone rock.

984. Has any estimate been made of the expense to be incurred?—Yes, and the amount is 9,000*l.*

985. Is there any party willing to contract to finish it for that amount?—We have not yet offered a contract, but my opinion is there would be no difficulty in obtaining contractors to do it. I think the prices I have allowed are quite ample.

986. What portion of that amount would be required to deepen between the old breakwater outward to the low water mark?—For the first 100 yards outward to the opening is 623*l.*; from the outer heads to the low water mark is 5,733*l.*, besides 10 per cent. for contingencies.

987. To what depth do you propose to excavate at the outer mouth?—The whole of it about three feet, just to take the present slope there is in it.

988. What vessel would it admit if finished to that extent?—Vessels drawing 16 feet of water at high water.

989. (To Mr. *Macdonald.*) Have you any funds by which you can make this excavation?—No.

990. What is the amount of interest payable on the money you have now borrowed?—About 2350*l.* a-year.

991. What other charges are there in maintaining the harbour?—About 700*l.*, or 800*l.* a-year, including the expense of management.

992. That, with the 2350*l.*, makes the annual expenditure 3150*l.*?—Yes.

993. The shore dues are put down in 1843 at 3050*l.*, what were they in 1844?—They have averaged that amount during five years.

994. Is there any probability of their increasing if the harbour is not deepened?—I think not.

995. Is there any probability of their continuing at that rate?—The harbour requires occasional dredging inside. The shore dues at present do not afford funds for this purpose, and unless they were increased by the harbour being deepened, so as to admit a larger class of vessels, I do not think that sufficient funds will be obtained in this way. I think if the harbour and the entrance to it are not deepened it will in time become comparatively useless. Freights for vessels coming to Arbroath with coal, I understand, have been charged 1*l.* a keel more than they would have been to Dundee under similar circumstances, in consequence of the difficulties caused by the shallowness of the Arbroath harbour.

996. Are the Board to understand that while the harbour remains at its present limited depth every vessel bringing cargo there is subject to a higher freight from the additional risk from shallow water?—Yes; small vessels are put to inconvenience, and it frequently happens that vessels of large size cannot enter at all.

997. If the excavation were made, as proposed, from three to four feet, what additional tonnage do you expect that would admit?—I believe vessels of 400 tons would get into the harbour. This is more than double the tonnage of vessels that can be well accommodated now.

998. Would that additional tonnage increase your dues?—No doubt it would; it would increase the trade in every way.

999. Can vessels with easterly winds take this harbour as a harbour of refuge?—Yes.

1000. Do small vessels, in point of fact, take it now?—Yes.

1001. Is it expected that if the harbour was deepened to that extent that the ordinary coasting vessels would be able to take the harbour?—Yes. Vessels of 300 tons would come at any time, I have no doubt.

1002. Are there any means at the command of the Harbour Trust, to excavate the harbour which is pointed out as being so necessary?—No.

1003. Upon what security has the money been borrowed?—When we commenced the improvement of the harbour nobody would lend money upon it; the security was thought to be doubtful; it was thought that the harbour would not stand, the works having to be constructed with so great an extension to the open sea. A public meeting was held, and appeals were made to the public spirit of the inhabitants and people in the neighbourhood, and they came forward some of them with their own money, and those who found it inconvenient to do

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that came forward and granted personal obligations in support of the security the harbour was able to give, and they did that to the extent of about 25,000*l.*

1004. Are the Board to understand that of that 50,000*l.* borrowed, 25,000*l.* is on the personal guarantee of individuals connected with the port?—About 25,000*l.* of it is. There were other people who lent their money and took the security that the Harbour Trustees could give.

1005. What was the original estimate of the harbour when first projected?—50,000*l.* was the original estimate to cover every thing. 40,000*l.* was to execute all the works and make a wet dock in addition, and the remaining 10,000*l.* was the price of the old harbour.

1006. Then the difficulty you are in is from the execution requiring more money than you contemplated at the time of projecting the harbour?—Precisely. I may state that the foundations were made deep with the public object of securing a harbour capable of admitting larger vessels, which the trade of the port required.

1007. And the limited amount of shore dues prevents your borrowing more, while the harbour remains in its present state?—Yes.

1008. (To Mr. *Leslie.*) In what state are the works at the present moment; do you consider them likely to be stable?—All the works are perfectly stable and substantial.

1009. Do you consider any further outlay would be necessary than in deepening?—No.

1010. What is the area of that harbour?—Six acres.

1011. Would the estimate you have given in enable you to complete the whole harbour, as originally proposed, or only the deepening?—Only the deepening.

1012. What additional sum would be requisite to finish the inner docks?—About 25,000*l.* including a pier on the north side of the entrance.

1013. What is the accommodation now without that new dock?—At present there are two tide harbours, and it is proposed to convert one of them into a wet dock. The whole area will not therefore be increased.

1014. As an engineer are you confident that these works will stand the sea?—I have no doubt of it.

1015. And that nothing is wanting to render the harbour available for vessels of the usual size frequenting the port, but deepening the approach?—I think not.

1016. Are you quite confident that the sum of 9000*l.* you have given in your estimate is adequate to remove the rocks to the extent you have stated?—I think so.

1017. Is there no danger when once excavated of being again filled up?—There will be a filling up in the interior of the harbour, but there is not any danger of the entrance filling up.

1018. (*Chairman.*) What is the cause of the interior filling up?—There is a small stream, which comes down and silts the harbour.

1019. Do you think a small dredging power would keep it down?—I think it would; we keep it down now by hand dredging.

1020. (Mr. *Hume.*) (To Mr. *Macdonald.*) What will be the depth of water at the entrance if deepened as proposed?—Ten feet at half-tide, both at springs and at neaps.

1021. To what extent, if that deepening is made, would it serve as a Harbour of Refuge for the usual vessels which pass along the coast?—Strictly speaking it would not be a Harbour of Refuge, but it would afford valuable shelter for all vessels not drawing more than 10 feet water, which is probably the usual average along the coast, at half-flood, and therefore for six hours out of the 12 it would be fully available as a Tidal Harbour of Refuge.

1022. Would it be possible to take the harbour during the night at that time of the tide?—Perfectly possible, if properly lighted.

1023. There are lights?—Yes, there are harbour lights.

1024. Are you aware whether those lights are properly situated to enable them to take the harbour at that time of the tide?—The lights at present are properly situated, but in the event of deepening the approaches they might require to be altered accordingly.

1025. From your knowledge of the coast is there much need of a Harbour of Refuge at that port?—Very great indeed. The greater part of the east coast of Scotland is well known as an iron-bound rocky coast, and with the wind on a lee-shore, is extremely hazardous. In strong north-west winds, too, which blow right out of the Tay, vessels commonly run down off Arbroath to get under the shelter of the land.

1026. Do you consider that the deepening of that harbour would be productive of benefit to the coasting trade generally?—Of so much benefit that I think it may be fairly stated as a subject of public importance.

1027. Do you consider that deepening it to the extent that Mr. Leslie has stated, of only three feet, would be adequate, if you look to it as an object of public importance?—Certainly not sufficient for all purposes, but as I have stated, to render it a very valuable shelter during six hours out of the twelve, for the greater part of the vessels that frequent that coast, and when the frequent distressing wrecks that occur on that coast are considered; for as I am informed, that about the year 1800 not less than 13 vessels were wrecked in one night in the short tract of coast between Arbroath and Red Head, only six miles to the north-eastward, I think we are fully borne out in the statement.

1028. If it should be deepened, would you limit the deepening, or would you extend the depth?—By all means extend the depth. The only possible excuse for not exceeding three feet would be the very limited means at the disposal of the trustees, but if Government were to give a small grant in aid of improvements at the entrance of Arbroath, I would then strongly recommend deepening from eight to ten feet, if, upon examining the slope of the shore, it should be found there was no great difficulty in doing so.

1029. Beyond the 700 feet to which you propose to excavate what water do you come

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to?—Into 18 feet at one cables' length distance, and six fathoms at a quarter of a mile beyond.

1030. (*Chairman.*) On the chart there is a rock to the eastward, called Knuckle Rock which is covered at three feet rise of tide. In the event of improving the harbour is it of sufficient size on which to erect a light or beacon?—Yes, and I should recommend that and another beacon on the Cheek Bush to the south-west as very useful guides into the harbour.

1031. (Mr. *Hume.*) Would not such beacons be excellent guides to ships?—Yes.

1032. (Mr. *Chapman.*) In making this harbour so good as you have described, do you think the Legislature would sanction a passing toll in its support?—I hope not; I should be sorry to see any more passing tolls on shipping for any circumstances whatever.

1033. Do you think the Government would consent to a grant to this individual harbour in preference to any other?—I do not recollect at this moment that any harbour with which I am acquainted on the coast of England has similar claims. The trustees of Arbroath Harbour have expended 58,000*l.* in improving it internally; and all that is now required is, to deepen the approaches to enable them to turn that depth to account; and considering the size of the town and the means at their disposal, I do not remember any place that has made so great a sacrifice as have the trustees of this harbour.

1034. (Mr. *Hume.*) (To Mr. *Macdonald.*) Is there not a railroad from Arbroath to Forfar?—Yes.

1035. Has not the trade of Arbroath been considerably increased by that means?—It has.

1036. Do you consider that deepening the harbour as now proposed, would tend to increase that traffic?—I do.

1037. And ultimately the dues might be able to pay off the debt contracted, for which individuals are privately responsible?—I have no doubt it would.

1038. If the harbour is not deepened, do you consider the Commissioners will be able to meet the charges upon them and pay off any portion of the amount resting on personal responsibility?—I do not think they will be able to keep the harbour up sufficiently and pay the debt, unless they get it deepened.

1039. Are the Board to understand that the harbour, on which 58,000*l.* has been already expended, will deteriorate, and a great portion of its benefit be lost, unless that sum is expended?—I think so.

1040. (Mr. *Chapman.*) Did the Government afford any facility or assistance in making this railway by any grant of money?—None.

1041. It was raised through the exertions of the shareholders?—Yes.

1042. (*Capt. Washington.*) Did not the trustees purchase the harbour from the Corporation of the Borough?—Yes.

1043. Did they not throw it open to the public?—Yes.

1044. (Mr. *Hume.*) Have you received any assistance from the Government in any way towards the formation of this harbour?—None whatever.

1045. By what means have the Harbour Commissioners been able to raise so much money?—I have already stated how much the inhabitants of the town and neighbourhood assisted the trustees in raising money. The first thing that was done was the acquiring of the harbour from the Corporation: it belonged to them, and they had the revenues of it for municipal purposes. Meetings of the inhabitants were held, and a proposal made that the Corporation should surrender the harbour. They said they could not do so, because they would have no means of paying the watching, paving, lighting, and other expenses of the town, which they were in the habit of doing out of the surplus revenues. Then the inhabitants met, and resolved that they would adopt the provisions of the General Police Act for Scotland, which give powers to tax the inhabitants for all these purposes. They told the Corporation, "If you surrender the harbour we will tax ourselves by adopting this Act;" and by that means, to the best of my recollection, 1400*l.* or 1500*l.* a-year was raised for expenses which used to be paid entirely out of the revenues of the harbour, and now the inhabitants are paying that sum yearly, in order to get this harbour made efficient. They are paying yearly a large sum of money, and will continue to do so. That was the first step taken. The inhabitants had previously been solicited to adopt this Act, and they rejected it. When it was put to them in this form, "You will get your harbour improved," they agreed to tax themselves for that purpose. The whole community agreed to it, and now continue to tax themselves; and I think about 1400*l.* a-year is raised for these purposes.

1046. (*Capt. Washington.*) Do the trustees derive any emolument from their office?—None whatever.

1047. None of the Commissioners are salaried?—None.

1048. All their services are gratuitous?—Yes.

1049. (Mr. *Hume.*) By whom are the Commissioners appointed?—Two of them are appointed by the town council of Arbroath, and the Provost of Arbroath is a Commissioner *ex-officio*, two elected by the town council of Forfar, and ten are elected by the 10*l.* Parliamentary voters of the borough of Arbroath, and four elected by the freeholders of the county, making in all 19.

1050. (*Capt. Washington.*) Are any of those ship-owners who have been at sea?—Yes.

1051. Who takes the general management of the harbour?—The trustees.

1052. (Mr. *Hume.*) Do they hold regular meetings?—Yes; they have stated meetings every month according to a standing order, and they are regular in their attendance. They have also standing committees, who hold frequent meetings.

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1053. Do they publish an account annually of their receipts and expenditure?—They do; they are printed, published, and circulated.

1054. Has every individual belonging to the towns of Forfar and Arbroath a right to have their accounts and examine them?—Yes.

1055. Are there auditors?—An auditor is appointed by the trustees annually as a body.

1056. Are the auditors paid anything for their duty?—Yes.

1057. (*Capt. Washington.*) What is the population of Arbroath?—About 15,000.

1058. (*Mr. Hume.*) What does the trade chiefly consist in?—Flax-spinning and manufactures.

1059. Coals?—There is a great import of coals and flax.

1060. And export?—Canvas and brown linens, stones for pavement, and corn.

1061. Arbroath itself and the district around are manufacturing districts?—Yes.

1062. Thread and flax-spinning?—Flax-spinning, and manufacture of canvas and brown linens.

1063. (Mr. *Chapman.*) What is the number of individuals who have given their personal responsibility for the payment of this money?—I think, from recollection, about 60.

1064. In the event of any advance being made by Government, would those gentlemen look for a return of the money for which they have become responsible?—I think not.

1065. They will still keep up the responsibility?—Undoubtedly. What they want is to make what is done effectual; it is not to relieve them.

1066. (*Chairman.*) They would hold those securities as a sort of debenture?—They remain effectual.

1067. You say you apprehend that if the harbour is not improved, the trade will deteriorate. Why should it not remain as it is now?—The inner portion of the harbour is filling up.

1068. (Mr. *Hume.*) Is any portion of the trade going to Dundee, in consequence of the harbour not admitting larger sized vessels?—Yes; and that adds to the expense to the people who are getting goods, because they have to send them overland to Arbroath.

1069. (Mr. *Chapman.*) What number of vessels entered the port of Arbroath five years ago, and what number entered last year?—In the year ending 15th October, 1840, there were 777 vessels, and 48,193 tons.

1070. What was the number in 1844?—The number of vessels was 749, and the tonnage 47,647.

1071. How does that tally with the number of ships that entered the same port ten years ago?—I have no means of answering that question.

1072. From your recollection, has it increased or diminished?—I should say it has increased.

1073. Notwithstanding the badness of the harbour?—Yes.

1074. It has continually increased?—Yes.

1075. Have the manufactures increased also?—Yes. I would add that during the winter before we got any use of the enlarged harbour, on various occasions, I should say nearly a dozen times, we could not receive another vessel; the port was so crowded that they were obliged to go to other places.

1076. (Mr. *Hume.*) Is not Arbroath a free port?—Yes.

1077. Having a custom-house to itself?—Yes.

1078. When was that established?—About a year ago.

1079. (Mr. *Chapman.*) What is the amount of harbour dues a vessel of 200 tons would pay?—The dues authorized to be levied by the schedule of the Act vary from 1½*d.* to 1*s.* 6*d.* per register ton.

1080. (*Chairman.*) Is the scale of duties regulated by the ports from whence the ships come?—Yes, whether they are foreign or coastwise. The amount levied on the goods is the same, but on the ships it varies.

1081. (Mr. *Hume.*) Have you any further statement to make?—I would mention that there is a balance of about 3000*l.* remaining unpaid; after all our money was gone, we were indebted to the contractors to that amount. Meetings were held, and appeals made to the Corporation and inhabitants again, and it was resolved, as there was no remedy, that the Corporation should assist them; and they have given their security for that in addition.

1082. If the money which you seek was advanced, every farthing of it is to be applied to the excavations and improvements pointed out?—Yes.

1083. The responsibility of the persons you have alluded to for the money already expended, must remain until the improved revenue of the harbour is sufficient to pay them off?—Yes.

1084. (To Mr. *Leslie.*) With regard to the information you have given as to deepening, have you anything further to add?—I would add that a general increase of three feet will give an increase, as far as regards the vessels, of probably five feet in many places; we may perhaps take off five or six feet from high places, and not more than a foot or two from low places.

1085. Are you quite confident that upon that estimate the deepening could be made so as to give the great facility of entrance you have pointed out?—I have no doubt of it.

[*The Witnesses withdrew.*]

Adjourned till 1 o'clock on Friday next.

Mr. *P. Stead* and Lieut. *F. Wilson Ellis*, R.N.

May 23, 1845.

Friday, 23rd May, 1845.

Present :—

Rear-Admiral BOWLES, C.B., in the Chair.

Capt. Sir G. Bremer, K.C.B.
Mr. Hume, M.P.
Mr. Rice, M.P.
Mr. A. Chapman, M.P.
Capt. Beaufort, R. N.
Mr. Godson, M.P.
Capt. Washington, R.N.

Mr. *Patrick Stead* of Halesworth,
and
Lieut. *Francis Wilson Ellis,* R.N.,
Harbour Surveyor of Southwold,
sworn and examined.

1086. (*Chairman.*) (To Mr. *Stead.*) What is your profession and place of residence?—A merchant and maltster at Halesworth. I possess freehold malt-houses and trade property. I pay this season above 20,000*l.* in malt duty to the Crown.

1087. Are you in the habit of trading to the port of Southwold, and for how long have you been so engaged?—I am, and have been in the habit of doing so since 1817.

1088. How much corn or malt do you export, and what coals do you import?—I shall export this season upwards of 20,000 quarters of malt and corn; of coals somewhere about 3000 tons; in some years we have more than 3000 tons, and in some years less.

1089. Who pays the chief dues of the port of Southwold?—I consider that the merchants pay them; and for this reason—the merchant hires the vessel; the captain pays the dues on corn and goods at the port; and, accordingly as the captain pays those dues, he charges; if I have coals through Southwold, I pay the Southwold dues. Again, if I had coals through Yarmouth, I should pay the Yarmouth dues and the carriage towards Southwold.

1090. Have you any complaint to make against the present state of the harbour?—I have made very serious complaints about the state of the harbour for very many years.

1091. From your own personal knowledge?—Yes. We have had very often a very bad bar.

1092. (Mr. *Hume.*) There is a letter addressed by you to the Admiralty on the 28th of June, 1844, complaining of the state of the harbour—did you write that as your own act, or at the request of any portion of the inhabitants of Halesworth?—I wrote it because I received great inconvenience in trade; but my neighbours received equal inconvenience.

1093. Was it in conjunction with them, or by your own act?—I believe it originated with myself.

1094. (*Chairman.*) Have you reason to believe, from your own knowledge, that the harbour was formerly in a better state?—Since 1817 I cannot say that it has been in a much better or a much worse state, but I heard the evidence given before the Commissioners of Southwold Harbour, and of the River Blyth in August, 1839, who took evidence at the town-hall of Southwold, and advertised for evidence once a-week for four weeks; all of which is printed.

1095. (Mr. *Hume.*) Were you present when William Blanden, of Halesworth, was examined?—Yes.

1096. Is it upon that evidence that you mention the former state of the harbour?—That is one of the evidences; he is the oldest man I am aware of on the river.

1097. State the result you have gathered from all that evidence?—Blanden stated "that he was 70 years of age; that he had been a wherryman between Halesworth and Southwold, 59 years; that about 50 years ago ships traded at Southwold of similar size as now trade there, and he never remembers being detained there for want of water, or upon the bar, until after the marshes on the banks of the river were taken in; that the wherrymen among themselves said, and considered at the time of the embankments being made, they would ruin the harbour, which, up till then, had been good. That no better harbour ever wanted to be up to the date of the embankments; that the tides 40 or 50 years ago ran a wonderful deal stronger than now, when we always required to bring up our wherries with an anchor, but now we find a quant (pole) is quite sufficient. That about 40 or 50 years ago he went pinpatching over the marshes called the Salts and Flats."

1098. Are they now dammed out from the flow of the tide?—I believe they are; that they were always under the waters at neap tides and spring tides; that there was a large creek and a great deal of water in it, where he had been up with his craft pinpatching. "I never was questioned about or refused; all the public went as a matter of right, and asked nobody at all; we took our own leave, and nobody said anything to us." He remembers the 200 or 300 acres being embanked, and that since that time the harbour had been getting worse and worse, and that there has not been back-water enough to keep the harbour scoured out; the tide not being nearly so strong now as 40 or 50 years ago. "I could now run my wherry down against the flood with a fair wind double the distance what I could have done with a similar then. We never had to go to the roads or bay in old times to lighten the ship, as they got in then without lightening, and come and lay along side the piers afloat. That the ships used to come in as soon as it was flood upon the bar, and would get over it in an hour or two; larger ships came in then than now ("The British Laurel" and "Old Providence.") The only thing that can be done now, is to get more back-water, and to run out the north pier 40 or 50 yards."

1099. Does the other evidence support the opinion given by Blanden?—Some of it varies, but generally speaking I think it does.

1100. (To Mr. *Ellis.*) Are you of opinion that the majority of the evidence taken upon that Commission was, that in former times within the memory of man, the harbour was deeper, the current stronger, and the bar less than at the present moment?—That is the effect of the evi-

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dence given, although I do not concur in it. I have known the place only about fifteen years, and therefore cannot speak from knowledge beyond that time. I would make one observation with respect to the evidence. Blanden says, "We never had to go to the roads or bay in olden times to lighten the ships, as they got in then without lightening, and I have seen ships drawing nine or ten feet water come in at half flood, and come and lay alongside of the piers afloat." It is a known fact that the harbour was so bad formerly that the masters of the ships built a lighter for the express purpose of going out to lighten their vessels in the roads before they could get into the harbour.

1101. (*Chairman.*) Do you speak from your own knowledge?—That lighter was in existence when I went to Southwold; it was purchased by the Commissioners of the harbour from the masters; it was used as a ballast lighter at the time I went there.

1102. Are you prepared to speak from your own knowledge, of the age of the vessel, and the purpose for which she was originally intended?—She was used before I went there for the purpose of lightening vessels; and I can show, I think, from documentary evidence, that she was used for that purpose.

1103. (Mr. *Hume.*) Are you prepared to say that larger vessels did not come into the harbour formerly, than can come in now?—No.

1104. Do you mean to say there were not larger ships?—I cannot say whether they were larger or smaller; I should say there were larger vessels formerly, because I think the harbour must have been better formerly, before the river was curtailed by the encroachment of the sea. (Mr. *Stead.*) I would remark that the meeting at Southwold being public, and advertised in the public papers, it was open to any person to bring in evidence of any nature, and to be examined before the Commissions sitting there in the public hall, but I am not aware that any evidence was brought in that said that that lighter was used. (Mr. *Ellis.*) The Commissioners of Southwold Harbour brought forward no evidence. The Commissioners of the River Blyth memorialized the Commissioners of Southwold Harbour upon the bad state of the navigation. The Commissioners of the Southwold Harbour, at the suggestion of the River Blyth Commissioners, appointed a committee for the purpose of receiving evidence; but there was no evidence brought forward to rebut anything that the River Commissioners alleged in their evidence.

1105. (To Mr. *Ellis.*) Do you consider that Committee would have done their duty if they had not obtained the best evidence they could from all parties?—The Committee was called for the purpose of receiving the evidence of the River Blyth Commissioners and such others as might be offered. No other evidence was offered that I am aware of in reply to the River Blyth Commissioners.

1106. Did you attend that Committee?—I did; I attended as secretary, and took down the evidence.

1107. Were you aware at that time of the fact that you have now stated, that that lighter was so used?—Yes.

1108. Why did you not bring evidence to that point?—The thing is so notorious in Southwold, that the question has never been raised or contradicted.

1109. In what way is it notorious?—I will show it in print. This is a book called "A Hand-book to the Port and Shipping of Southwold," printed in the year 1842. It is ostensibly written by Mr. James Maggs, but is presumed to have been written by Mr. Jermyn, the former collector of the harbour under the Southwold Commissioners, whom I succeeded. He says "that previous to the year 1790, few vessels belonging to the port were able to pass the bar with full cargoes; and that in that year the masters and owners of the principal vessels had a lighter called 'The Good Intent,' built at Yarmouth, for the purpose of taking out part of their cargoes in the bay, to enable them to enter the harbour."

1110. What sized vessels does he allude to?—The vessels of the port, which range from 70 to 80 tons.

1111. Does he mention them to be vessels of 70 or 80 tons?—No, he does not.

1112. Then, upon what authority do you state that; you say you have only been 15 years there?—I presume they were 70 or 80 tons vessels of the ordinary tonnage trading to the port.

1113. They may have been colliers from Newcastle?—Newcastle vessels come there but rarely. I offer the passage I have read, not as evidence of the size of the vessels, but that a lighter was employed for the express purpose of lightening the vessels. There is one expression that bears on the question:—"The cost of the 'Good Intent' exceeded 200*l.*, and it was for many years a very profitable concern; as most of the vessels resorting to the port made use of it. Upon the extension of the South Pier in 1806, however, the bar was found to be so much improved by it that vessels with full cargoes entered without difficulty; the lighter became altogether useless and unprofitable, and was sold in 1815, by those for whom it had been built, to the Commissioners of the haven, for about a fourth of its original cost, to be used as a dredger upon the shoals of the river." That lighter was sold when I first went to Southwold. —(Mr. *Stead*) Mr. Jermyn is an interested individual, inasmuch as he was the collector.

1114. (*Chairman,*) (To Mr. *Stead.*) Have you made representations as to the neglected state of the harbour, and have those representations been paid attention to?—The first representation I made was on the 4th of August, 1827. I was then getting deeply into the interest of Southwold, because I was extending my trade in malthouses. I found the quality of barley good for the purpose for which I wanted it, and I increased them on that account. In 1827 I began to pay active attention to the harbour of Southwold, and I wrote to Mr. White, the clerk of the Commissioners. I urged them to adopt public open contracts like Yarmouth and other places; I urged them also to straighten the course from Walberswick Quay to the South Pier, and remove the Billar Shoal, contracting the passage on the north, would leave a strong hope that the channel and bar would be infinitely benefited. On the 13th of September, 1828, I wrote about the accounts; I wanted to get the accounts. On the 25th of September, 1828, I urged them to dredge the harbour, and I took over Mr. Crane, who was the

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resident inspecting engineer at Yarmouth, with me, to get his opinion, as he had improved Yarmouth harbour wonderfully. He pointed out a cut through what is called the Bellar Shoal would do a great deal of good to the harbour, and to straighten the course of it. I told them there were 29,655 quarters of corn shipped annually at Southwold, and that the loss sustained I valued at 1*s.* per quarter, from the want of dispatch, making 1452*l.* 15*s.*, and that one-half part of the trade was diverted to other channels, making 2965*l.* 16*s.* per annum loss.

1115. What was done?—Nothing was done, but they went to Parliament for a new Bill.

1116. You are speaking of the Southwold Commissioners?—Yes.

1117. In coming to Parliament, did you make any efforts to improve the barbour?—I made all the efforts I could to get a good bill, and to get Commissioners appointed by the traders, payers of dues, and growers of corn.

1118. Did you get that effected by the Bill?—I did not. The corporation of Southwold, The bankers, merchants, shipping owners, The Commissioners of the river Blyth, growers of corn attending Halesworth market, and myself, presented petitions to the House of Commons, praying them to introduce a similar constitution of Commissioners as were in other harbours such as Glasgow. Liverpool, Dundee, Newcastle, and Leith. I asked them to introduce Commissioners who were to be appointed by the several traders, because I thought they would attend more to the harbour than we could expect gentlemen to do in the country whose station in life does not lead them into those accounts that merchants and traders are familiar with.

1119. What was the first Act for regulating the harbour of Southwold?—That of 1746.

1120. What was the character of the Commissioners appointed by that Act?—The bailiffs of the borough, 12 proprietors of the adjoining lands, and one clergyman.

1121. Had the town of Halesworth the appointment of any portion of the Commissioners?—None. They were to be self-elected.

1122. In any of the subsequent Acts had the town of Halesworth the appointment of any portion of the Commissioners?—Never. Self-nomination and election was the constitution.

1123. In 1830, when you came to London, you have stated that you endeavoured to obtain a kind of representation of the interests of the town in the new Bill?—Yes.

1124. You did not succeed?—I did not.

1125. How many Commissioners were appointed by the Act of 1830?—Thirty-two.

1126. What class of persons were appointed, and are now Commissioners?—The class of persons who were appointed by this Act which I took so active a part in were all landed proprietors, with the exception of two, and those two happened to be at the time, I believe, the bailiffs of Southwold. There was a strong objection made to the bailiffs being introduced into the Bill, and that strong objection was met by a petition from the borough of Southwold, convened in the public hall.

1127. What date?—In the spring of 1830. This following resolution was passed by acclamation. Resolved unanimously in the Common Hall of the port and borough of Southwold, that the corporation seal be not attached to any consent or grant of lands, beach, or other right required by the Bill in its present shape. And that no such grant shall be allowed till a full, fair, and equal representation of Commissioners be introduced in the present or any future Harbour Bill of the borough of Southwold, of merchants, ship-owners, and landed proprietors to be elected annually; and a petition was then agreed on, praying "That the bailiffs and commonalty of the borough of Southwold may be empowered to nominate and elect from time to time six Commissioners to be appointed under the said Act." A meeting was afterwards held, and the following petition was the result of the merchants, ship-owners, ship-masters, and others of Southwold, that the bailiffs for the time being for the borough of Southwold may be restored and inserted as Commissioners. "That the clause appointing the Commissioners in the said Bill may be expunged, and one of a more open character introduced. That the nomination and appointment of Commissioners be not confined to the extent of landed interest, or the amount of interest derived from land as required by the said Bill only; but that the said Commissioners may consist of merchants, ship-owners, and payers of dues equal in number to those representing the landed interest." That all such Commissioners be elected and appointed from year to year only; also a petition from the merchants, &c., of the river Blyth and inhabitants of Halesworth, who pray that inquiry may be made "whether the embankments of the lands and the stopping up the creeks have been necessarily and equitably made, as the prosperity and goodness of the harbour depend so especially thereon."

1128. Did you come to Parliament to enforce those resolutions?—Repeatedly.

1129. Did you obtain any alteration in the Commission?—The bailiffs, I think, were introduced into the Bill at that time as bailiffs upon the third reading, and Clause A limiting the port added.

1130. Who were constituted Commissioners by the Act of 1830; what class of people were appointed?—Landed proprietors, clergymen, all justices of the peace for the county, and bailiffs of Southwold.

1131. How many of each?—All the justices of the peace, fourteen clergymen, and sixteen landed proprietors (two bailiffs of Southwold, who were merchants), are named in the Act.

1132. Has there been any alteration in the character of the Commission since?—They have introduced a few more merchants since that time.

1133. What is the state of the Commission now?—All the justices of the peace, ten clergymen, seventeen landed proprietors, their lawyer, one merchant, one brewer, and one chemist. (Mr. *Ellis.*) By the Municipal Bill, the town council have the power of electing two *ex officio* Commissioners of the harbour, and they require no property qualification. (Mr. *Stead.*) By section 7 of the Act. "If any person not being so qualified, or not having taken the said oath, shall presume to act, every such person shall for every such offence forfeit and pay the sum of 50*l.*"

1134. (To Mr. *Ellis.*) Do you know that all these clergy are qualified with an income of

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100*l*. a year from land as formerly in the Act?—I apprehend so. I apprehend they are completely within the terms of the qualification.

1135. As landed proprietors?—Not as landed proprietors, there is a double qualification.

1136. Have you attended any of the meetings of the Board of Commissioners?—Every meeting.

1137. Can you state what portion of the clergymen attend every meeting?—On Saturday, 15th July, 1843, there were present four clergymen out of twelve Commissioners.

1138. How many belonging to the town?—Two.

1139. Is that the general character of the meetings?—I should say generally so. On the 20th of July, 1839, there were present three clergymen out of twelve Commissioners.

1140. How many of the town?—Three.

1141. (To Mr. *Stead*.) As the inhabitants were unable to obtain that modification of the Bill, have they been satisfied with the management of the harbour ever since?—We have been very much dissatisfied with the bar. I had two vessels loaded with corn bound for Newcastle and Perth in 1838, called "The William," and "The Hawk," under a hundred tons burthen; they were detained; they were lost afterwards, one with all hands on board, and the owners ascribed the loss to that detention because it threw them into that dreadful gale which occurred in January, 1839.

1142. Do you mean that they were only able to leave the harbour at high spring tide?—Not even at high spring tide could they leave the harbour. Other vessels were detained at the same time; I have had six or seven detained frequently. On one occasion, in 1838 or 1839, we had the harbour beached up so high and dry that carriages and horses passed outside of the pier head.

1143. Do you mean that the bar had been raised in 1838 so high that persons could walk across?—In 1838, or 1839, not only persons, but even horses and carriages for many days. A great number of vessels were inside; no water ebbed in or went out; it was a perfect lake; and then there was a number of vessels inward bound that could not get in, beating about for shelter in Yarmouth Roads, &c., one stranded and lost totally on the bar called "The British Queen."

1144. Had that bar been thrown up by an easterly gale?—As I do not live at Southwold I forget how it happened. The want of back-water was not sufficient to keep the harbour open.

1145. Do you mean to say that any impediment to the flow of the tide up the river had caused that?—I mean to say that a continual accumulation of tide after tide bringing in beach choked it up, while I should imegine if we had had the natural backwater, and it had not been banked off, that water would have been sufficient to keep the harbour open.

1146. How was that tidal water banked off?—It was banked off by gentlemen in the neighbourhood whose land adjoined; they enclosed the land on each side of the river.

1147. To what extent has that been done?—In order to speak correctly I will state it from Mr. Walker's Report, "Showing the area of the embanked lands, formerly overflowed by the tidal waters of the River Blyth; with their situation and level below a six feet six inch tide, and the quantity of backwater excluded thereby from scouring the harbour."

1148. State the total area and the total amount of water excluded?—1504 acres of marshland, surveyed, excluded 148,296,490 cubic feet of water; of marshes which he did not survey, 1200 acres, if at the same levels, excluded about 118,637,192 feet. The total quantity embanked was 2704 acres, and the total quantity of water excluded was 266,933,682 cubic feet.

1149. Do you, and the inhabitants with whom you have communicated, consider that the injury done to the navigation to which you have alluded, has been caused by these lands on each side of the river being embanked, so as to exclude the flood tide?—Yes; we do believe that is the cause of the harbour being so bad.

1150. Do you know under what authority these lands have been enclosed?—I never heard of any authority whatever.

1151. (To Mr. *Ellis*.) You have seen Mr. Walker's Report?—Yes.

1152. Are you aware of the inclosures to which that Report alludes?—I know the inclosures described in Mr. Walker's Report.

1153. Do you know by what authority the inclosures took place?—I apprehend that the landlords inclosed them, considering them as their own property. I know there is an Act of Parliament which prohibits any embankment being made, which was passed in 1806, but none previously to that.

1154. What Act do you allude to?—It is the 46th of George III., chap. 153. It is intituled "An Act for the preservation of the Public Harbours of the United Kingdom."

1155. Is it a general Act?—Yes, for all the harbours of the United Kingdom.

1156. (Mr. *A. Chapman*.) That relates to the jurisdiction of the Admiralty over harbours?—Yes.

1157. (Mr. *Hume*.) Has any of these inclosures taken place since 1806?—Very immaterial ones, as stated by Mr. Walker.

1158. Up the river?—I am not aware of any up the river.

1159. (To Mr. *Stead*.) In offering the opinion you have given of the injury done by inclosing those lands, can you give the authority of any engineer for that opinion?—Mr. Rennie's, on the 6th of January, 1820.

1160. To whom was that made?—Addressed to the Commissioners of the Harbour of Southwold.

1161. What is the purport of that?—"There is little doubt that the harbour of Southwold has, at former periods, been of a much greater depth than it now is, as will hereafter be shown; and that for many years past it has been getting gradually more shallow, owing to the embankment of the salt marshes, over which the tide used to flow, and the stopping some of

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the creeks which communicated with the channel of the river Blyth. By these changes the influx of the tide water has been diminished, and consequently the efflux thereby diminishing the velocity of the current, so that the matter which formerly was not sufficiently heavy to resist its strength, gradually became so.

1162. Is that the opinion you allude to in support of that which you have now stated as causing an injury to the bar?—That and many other opinions besides.

1163. Does Mr. Rennie afterwards state at that time the quantity of land that had been embanked?—He says that about 1100 acres of ground, over which the tide used to flow, have been embanked.

1164. What depth of water flowed over the marshes?—I can only refer to Mr. Rennie's report, who takes an average over 1100 acres at that time.

1165. (*Capt. Washington.*) Did Mr. Rennie survey and carry a level over the whole of the river and marshes?—No, he did not.

1166. Did Mr. Walker take the levels?—Mr. Walker had two assistants down there several months taking levels and measuring the land.

1167. What was the general result of his survey?—The result of Mr. Walker's survey is the table given above in answer to Q. 1148.

1168. (Mr. *Hume.*) What evils does Mr. Rennie point out as likely to arise from embanking the marshes?—"The quantity of surface contained within the present embanked channels of the River Blyth, creeks, and low embanked ground connected with it, as far as I can ascertain, may be about 200 acres, on a part of which the tide may rise five feet on the average; on others, not two feet; perhaps if four feet are taken it will be a full average; and if six inches only are taken as the average height, that the tide formerly flowed over 1100 acres now embanked, the diminished force of the current will be nearly in the proportion of ten to four. This is confirmed by the evidence of John Church, formerly a branch pilot but now master of a vessel, and who has been about 52 years at sea. He said that above 30 years ago the current of ebb was so strong that they were obliged to make the vessel fast by cables, and a boat could not pull up the harbour; but that now a vessel could stem the current with a good tow-line, and a four-oared boat could row up at any time. I have been thus particular in stating the evils arising from embanking the marshes, over which the tide used to flow, that I may impress on your minds the necessity of preventing such embankments in future, unless a receptacle is made somewhere else in lieu of the embanked lands; for unless this is strictly attended to, the harbour will go on getting worse until it will be entirely lost, and I am not aware that any remedy can be substituted for the deprivation of back water. To destroy the embankments already made, and to allow the tide-water to flow into its ancient receptacles, is no doubt the most obvious and effectual remedy that could be devised."

1169. Does he afterwards allude to any remedy for that beach which you say grew up into a bar?—"I am not aware of any means by which this beach could be kept out; but if the backwater were sufficient, what was brought in by the tide would be scoured away in the ebb;" and then he recommends a steam-dredging engine to scour away the shoals that would arise.

1170. Is there any other surveyor whose opinion you can state?—No other surveyor; but most of the captains and other evidence recommended such like.

1171. Has that recommendation of Mr. Rennie, with regard to embankments, been attended to?—There has been nothing done to abate it.

1172. Has any new embankment been made since that time?—I think there is a little made, about 36 acres of land near Southwold are enclosed.

1173. What do you consider ought to be done to remedy the present state of the harbour?—The same remedy that was applied at Wells, that is to take the banks down.

1174. What case do you allude to?—A case at Wells. It was decided upon an opinion given by Mr. Serjeant Grose, on the 31st January, 1778.—(*App.* p. 166.)

1175. Was the right of taking down those embankments contested?—It was contested in three several trials at law.

1176. What was the result?—They took place from 1779 to 1784.

1177. What was the opinion of Mr. Serjeant Grose on that occasion?—"I am of opinion that all the embankments which by preventing the flow and reflow of the tides, stop up the harbour, and are prejudicial to the navigation, were nuisances at the time they were made; but some of them have existed so long that there will be some difficulty in getting them removed. The best way to attempt it will be by indicting those persons who have made or continued the last of the embankments which are prejudicial to the harbour. It would be of too dangerous a consequence, I think, to attempt to abate them, by pulling them down, because the mischief might be infinite, and might be prejudicial against those who endeavour to remove the nuisance. I think the Commissioners under the Act for preserving the harbour, by virtue of that clause which enables them to do what they think fit for the purpose of improving and maintaining it, may apply as much of the money raised under the Act in support of such a prosecution will, in my opinion, be doing that which will assist to improve and maintain the harbour; but before such indictment be preferred, or any thing done towards removing the embankments, I would recommend an application be made to the Lord of the Manor, stating the inconveniences occasioned by the embankments, and begging him to remove them. If he sees the application in its right light, I think he may find out some plan to remove the nuisance complained of, without doing much injury to the land embanked, which would be the most desirable object on both sides."

1178. Does it appear that application was made to the Lord of the Manor?—Three several trials followed, and the result of those trials was, that costs and expenses to the amount of 562*l.* were paid by Sir John Turner, and there was an injunction granted by the Court of Chancery in 1781, restraining the Commissioners from removing the banks. This injunction was dissolved, and they were at liberty to throw down the same. After these proceedings, it appears

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by a minute, that the water upon a spring tide flowed as far as the ancient limits of the port, by which we may infer that the banks were all removed. (*See Appendix*, p. 188.)

1179. Was the result of that trial to remove those encroachments?—It was.

1180. Have you any other decisions respecting Southwold?—Mr. Chitty's opinion was taken.

1181. At what time was that opinion taken?—The 4th of January, 1839.

1182. What was the occasion of his opinion being requested?—I found so much difficulty in my trade, that I put a case through my lawyer to Mr. Chitty.

1183. What is his answer?—"It appears to me under the circumstances stated, that the embankments and obstructions in question are public nuisances, as being an injury to the harbour and the passage of ships: (Callis, on Sewers, 76; Hale, De Jure Maris, 21; Hawkins, Pleas of the Crown, book i., chap. 32, s. 1—11.) As such nuisances, they may be abated and removed; or the erectors or maintainers of them may be indicted, or have a criminal information filed against them, or if any individual has sustained any special injury arising from them (as by the detention of his ships in the harbour, or the like) he might maintain a special action on the case against them: (See per Lord Ellenborough, R. *v.* Dewsnap, 16 East, 196; Greasley *v.* Codling, 2 Bing, 263.) Of these remedies, I should at all events for the present advise the adoption of the one by indictment only; which may be prosecuted at the instance of any individual who may think fit to resort to it. I should advise the indictment to be against the parties who have erected or maintained the most recent of the embankments causing the nuisance. I do not think that the length of time during which the embankments have existed will legitimatize them: (Weld *v.* Hornby, 7 East. 195; R. *v.* Cross, 3rd Campbell, 227; Coupland *v.* Hardingham, id. 398; Vooght *v.* Winch, 2 B. and Ald., 662. There is no limitation of time for the prosecution by indictment. The responsibility to an action at the suit of any person specially injured would cease at the end of six years from the occurring of that injury. Those persons who erected the embankments since the 46 Geo. III. was passed may, I think, have subjected themselves to the penalty imposed thereby. 4th June, 1839." (*For Case, see Appendix*, p. 188.)

1184. Did you on receiving that opinion take any legal measures, by indictment or otherwise, to remove the embankment?—I considered it was the duty of public Boards to do that, and not private individuals. I applied to the Commissioners of the River Blyth in 1839, and to the Admiralty, the Woods and Forests, and House of Commons, in 1844, and the result is the appointment of this Commission.

1185. You were at the expense of obtaining the opinion?—Yes.

1186. You did not think that you, as a private individual, should be put to the expense, but you applied to the Commissioners of the River Blyth?—Yes.

1187. When did you make the application?—On the 15th of June, 1839.

1188. What was the application you made?—I drew the attention of the Commissioners to the ruinous state that the harbour of Southwold has been reduced by the embankments of the marshes and stopping of the creeks, and submitted a printed report of Mr. Rennie, and I produced reports from various other harbours. They resolved to memorialize the Commissioners of Southwold, and the effect of that was, that the Blyth Commissioners examined six captains who were then in attendance; and those captains attributed the bad state of the harbour to the embankments. They conclude thus, "Finally all the captains declare that it is their decided opinion, the deprivation of back waters, occasioned by the embankments, causes the harbour of Southwold to be reduced to its present deplorable state. Further, that it is their unanimous opinion the extension of the old north pier and limiting the width of the present channel is essential to meet the new state of the back waters. And lastly, they admit the easterly winds have been lately more prevalent than usual; but still, that the state of the harbour has been getting gradually worse for several years past, and that if something is not done they must leave the port for elsewhere to obtain a livelihood.

1189. Did the Commissioners take any other steps?—They memorialized the Commissioners of the harbour, and the Commissioners of the harbour upon a meeting appointed a public investigation of the matter at the town hall of Southwold.

1190. Had the Blyth Commissioners any power of themselves to abate any of the nuisances by removing the enclosures?—I am not aware that they could have done it.

1191. What is the jurisdiction of the Commissioners of Southwold and the Commissioners of Blyth?—The Commissioners of Southwold Harbour have ample power to do all that is necessary.

1192. What is the extent of the jurisdiction upwards?—It is not defined.

1193. What is the jurisdiction of the Commissioners of Blyth?—They have gone down as far as Wolsey Creek.

1194. Do you understand that from Wolsey Creek to the sea is under the Southwold Harbour Commissioners?—I should think that it is.

1195. Is not the jurisdiction of the other parts under the Blyth Commissioners?—The Blyth Commissioners have performed their duty as far as it is necessary for the purpose for which they were established, that is, for the navigation of small boats.

1196. Are the Blyth Commissioners under an Act of Parliament?—Yes.

1197. (*Capt. Washington.*) Does the Act state for small boats?—When I state for small boats, it is for wherries.

1198. (Mr. *Hume.*) Under what authority do the Blyth Commissioners act?—Under the authority of the Act of 30th Geo. II., chap. 47.

1199. Have they any power of removing the embankments so as to improve the navigation?—The embankments do not interrupt their navigation for small craft so much as they interrupt the navigation of the harbour and bar.

[*The Witness withdrew.*]

Adjourned to Wednesday next at One o'clock.

Patrick Stead, Esq.

May 28, 1845

Wednesday, 28*th May*, 1845.

Present:—

Rear Admiral BOWLES, C.B., in the Chair.

Captain Sir GORDON BREMER, K.C.B.	Captain BEAUFORT, R.N.
Mr. HUME, M.P.	Mr. GONSON, M.P.
Mr. RICE, M.P.	Captain WASHINGTON, R.N.
Mr. AIRY, Astronomer Royal,	

Patrick Stead, Esq., further examined.

1200. (*Chairman.*) Will you be so good as to state generally any further complaint which you have to make against the river Blyth, and the harbour of Southwold?—I think that next to the removal of the embankments made by the landowners, which shut out the tidal waters, a dredging should take place, and an equalizing of all the sections of the river, and cutting of sharp corners, and above all the removal of Blythborough Bridge. Mr. Walker says "the bridge is a disgrace to the county and the navigation, and ought not to be tolerated another year."

1201. Will you explain why you consider the bridge an injury to the navigation?—Because the sectional area is too small; the sill is too high, and the soffit of the arch is too low. I have recommended the removal of that bridge for a long time. The trustees of the road would not consent to that, nor the magistrates of the county, although the trustees of the road have removed a bridge of far inferior importance, the removal of which cost a great deal of money, and it did not require to be removed; it tumbled down several times; it is called Wangford Bridge.

1202. (Mr. *Hume.*) What distance is that from Blythborough Bridge?—From three to four miles.

1203. (*Chairman.*) Is the new bridge so built that it does not impede the flow of the water?—It is a bridge over a part that communicates with another branch of the river that is not navigable, which it leads to the river. There is a large quantity of land which Mr. Walker does not map to the westward of Wolsey Bridge. That also would add greatly to the back water. Mr. Clissold, in his pamphlet, values such marsh land at 3*l*. an acre rent; some land he proposes to embank for the benefit of the harbour, called Buss Creek, and, he says, that there are 100 acres of it, and that it would be worth 300*l*. per annum on a rough estimate, that is, from Buss Creek and the lands adjoining. I have made a calculation of what the rental would be, if we could get that land for the benefit of the navigation; the quantity of land embanked altogether, according to Mr. Walker's account, is 2704 acres, and at 3*l*. an acre, it would be 8112*l*. per annum. According to the calculation, at 30*s*. per acre, the back rent due would be 317,498*l*., reckoning the back rent according to the dates of the embankment, as stated in old Mr. Rennie's Report of 1820. I have asked the Commissioners to use a rake to deepen the river, such as was used in order to cut out the Victoria Channel at Liverpool, and such as is used at the West India Docks in London; that they should have a steam-vessel to tug out and in ships at high water, and rake out the mud at low water; and that they should build concrete faced with rubble work instead of wooden piers.

I reckon that the tides at Blythborough flowed about the same as they do now, that is, comparing the Report of Mr. Langley Edwards in 1757 with that of Mr. James Walker in 1840; therefore, it cannot be said that the embankment of land has raised the level of the tide, or carried it to a further extent up the river; and it is proved by the evidence printed by the Commissioners of the River Blyth, that the locks which were built upon the river did not commence until the river was beyond the influence or reach of the tide; the first two locks being built upon land which was purchased by the Commissioners, and through which the canal was cut, and Bulchamp and Blyford, the two lowest of the five locks, erected thereon. The Commissioners of the River Blyth have very much added to the quantity of back water, by deepening and widening and scouring the upper part of the river and by making a new cut, called Collinson's Cut; and, I think, that the River Commissioners have done all that was requisite for boats, but that the Harbour Commissioners have not done anything above the harbour for the benefit of the bar. I think that their expenses have been excessively high; as regards their establishment of officers they are double the expense of other ports, such as Wells and Yarmouth, compared with their revenue. I think that the dredging was done at double the expense that it ought to have been.

1204. What was the expense?—They paid 5¾*d*. for the lighters carrying the sand and mud from the dredging engine, whilst I believe it might have been done at 3*d*. a ton. At the river Tay, where I know dredging is carried to the highest perfection of any part of this kingdom, they do the whole of the work for about 2¼*d*. per ton, including every expense, the engine, machine boats, and everything; and I should beg leave to draw the Commissioners' attention to a pamphlet which I have printed and it is now laid on the table, containing a letter at p. 56, dated 23rd October, 1839, from Messrs. Wright and Currie, of Perth; and another at p. 57, from the managing man of the dredging department in the river Tay, dated 9th October, 1844, showing that the dredging was done in that river at from 2*d*. to 2¼*d*. per ton for gravel; and from 3*d*. to 4*d*. per ton for clay. (*See Appendix*, p. 168.)

The detention of vessels by the bar that were loaded by me, for want of water over the bar, has been excessive. I loaded the "Lord Exmouth" on the 6th of January, 1840. The cargo was landed out of condition, and she was reloaded with the 668 quarters of barley on the 19th

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of February; she could not sail before the 4th of April, three months; that is a total destruction to any brewer's interest, because a brewer cannot malt barley in the summer months.

1205. What depth of water did that vessel draw, and what depth was there on the bar during that time?—I have not the information here, but I can get it.

1206. Of how many tons burthen was the vessel?—I suppose about 80 tons. I could enumerate 15 or 20 vessels that were delayed in a similar manner and stopped for various and long periods. It has been to that extent, that although I used to ship from 10,000 to 50,000 quarters of grain a-year at Yarmouth and at Southwold, &c. I have been compelled altogether to give up the trade of shipping corn.

1207. (*Chairman.*) When did this detention begin, and what was the state of the harbour when you first began business?—When I began business I lived at Yarmouth; we did not find so much difficulty at first, we found it growing upon us.

1208. (Mr. *Hume.*) What was the depth of water at first?—With the same class of vessels when first in business, I did not find so much difficulty as I did afterwards, the bar has been getting worse, and the complaints and losses which came upon me were so great, that I gave up the trade of shipping corn in 1840, and several merchants were ruined by the delay and loss of markets; they could not calculate what time would be occupied, and barley is of that perishable nature that after the month of April it is only fit for grinding.

1209. (*Chairman.*) You came to reside at Halesworth in 1817?—My business was in Yarmouth up to the year 1840. I had had a dwelling-house at Halesworth and Yarmouth. At Halesworth, Beccles, and Yarmouth I had houses of business. I resided at Yarmouth until 1838, and at Halesworth thereafter. In 1821 I began to malt there.

1210. Is it within your knowledge that any other merchants have been obliged to give up the corn trade at Southwold, in consequence of similar inconvenience?—Yes; one of the largest corn merchants, and of the longest standing, Mr. Jacob Mealing, left Southwold 30 or 40 years ago, and went to Norwich to carry on his trade; he and his son carried on the largest trade in the county of Norfolk; at one time they were the largest corn merchants in Norwich.

1211. From what port did they ship?—From Yarmouth. Mr. Jacob Mealing lived at Southwold, and carried on his trade at Southwold formerly, and he shipped at Southwold. William Blanden, wherryman, can give you much better information upon this, because he is an old man and knows the parties.

1212. Have you any further evidence that you wish to give?—We have a very small quantity of land-waters flowing down to Southwold, and therefore we ought to be supported with all the tidal water we can possibly get. By Act Anne 1, cap. 7, the Crown seems to have relinquished all Crown lands, and the country took them at that time; it was a bargain made between the Crown and the country upon Anne's Civil List being made, and in that Act there is a very particular provision respecting Crown lands.

1213. (Mr. *Hume.*) Do you consider that the lands which have been inclosed, and which were formerly overflowed, were Crown lands?—Most distinctly.

1214. You allude to that Act as giving to the public the right over all land within high water mark?—Wherever the ordinary spring tide flowed. The Act also provided for a rental of land in certain cases.

I think that the two lower reaches of the Halesworth Canal ought to be let out at every spring tide.

1215. Would the tide in that case flow up?—No.

1216. What advantage then would there be?—A quantity of scouring water would come down. My proposal to the Harbour Commissioners, when the price of iron was low and freights low three years ago, and all kinds of works so low, was that they could have made each of the creeks available as receptacles for water by constructing portable iron-framed sluice-gates across, that those creeks together with the two lower locks on Halesworth Canal, should be opened at such a period that the whole would come down simultaneously at the last quarter ebb upon the bar at Southwold.

Mr. Rendel, civil engineer, has given an opinion upon an abstract case which does not at all apply to Southwold. Lord Stradbroke produced this opinion to the Commissioners of the harbour at the annual meeting of the 20th July of last year, and mentioned it as an argument to show that the embankment had done good instead of harm to the navigation; and I believe Mr. Rendel now states that his opinion is by no means applicable to Southwold Harbour.

The limitation of the boundary of the harbour was taken out in the House of Lords. "Clause A" was added at the third reading of the bill in the House of Commons,—"that the limits of the said harbour of Southwold shall, for the purposes of this Act, be deemed and taken to extend to the distance of 100 yards above a certain quay called Walberswick Quay." A petition was sent up to the House of Lords by the Corporation of Southwold, praying "that such alteration be made in the said Bill as shall effectually prevent and restrain the Commissioners acting under the Blyth Navigation Act from claiming and imposing the tolls and duties mentioned in their Act, which may be shipped from and landed at the said quay called Blackshore Quay, by extending the limits of the said harbour to or beyond the said Blackshore Quay." The House of Lords took that money clause out of the Bill, and sent it back to the Commons for their approval. I then took steps in order to throw out the Bill in the House of Commons; but a promise was made me that four or five Commissioners might be elected at the first meeting, under section 6 of the Act, from merchants and others from the town of Halesworth; but they were not appointed, and three letters were written, which are printed at pp. 5 and 6 in the printed evidence laid on the table, addressed to Sir Thomas Gooch, Mr. Hume, and Lord Stradbroke.

1217. Sir Thomas Gooch was the member in charge of the Bill?—Yes: indeed I may say before the Committee of the House of Commons sat, and before the member for the county

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took the chair, we agreed that no question should be gone into of past grievences; that we would endeavour to do everything possible to make it a good harbour in future, and with the understanding that there should be other periodically elected Commissioners introduced; but they delayed the Commissioners' clause until they had gone through all the Bill. I think there were six members sitting on the Committee, three of whom were elected by the Bill, and two of those three named in the Bill, so that the Committee elected themselves, which could not happen now under the present improved system of Committees in the House of Commons. That caused a great deal of opposition. Four or five petitions were presented against it, and not one in favour of the Bill, except the promoters' petition; a fifth petition against the Bill from growers of corn at Beccles came too late. The old Commissioners presented a petition for the new Bill, and they never got any one else to support it; so that we consider ourselves very hardly dealt with by that circumstance, particularly when I believe I am paying 300*l.* and 400*l.*, and sometimes 500*l.* a year in port dues, the whole revenue of the port being 1100*l.*; and it is a hardship which should not exist in the English constitution.

1218. (Mr. *Hume.*) You have paid that on the vessels employed by you?—I may fairly state above 300*l.* one year with another, during the existence of the Bill. Mr. Catt, of Brighton, is here, who will prove that he and his partners are large buyers of barley, and that they would not give me orders to ship it at Southwold, but only at Yarmouth. I gave up the barley trade and shipped malt, for it does not signify when malt comes up to London, because the brewers have from 20,000 to 30,000 quarters lying here in store. Another objection against this Bill, is that the qualification of Commissioners is too high, and in consequence they cannot get Commissioners; and further, I believe that the whole proceedings of the Commissioners are illegal, because some have been admitted without taking the oath, which, by the Act 10 Geo. IV., cap. 48, they are bound to take; the present Commissioners that are acting, I believe, have not all of them been sworn, and such appears to be liable to 50*l.* penalty; and the whole of their proceedings I therefore consider are illegal. I have consulted the collector of customs at Yarmouth, and others who are acquainted with the trade, and lawyers, and I believe I could run my ships up to Blythborough Bridge, and not pay anything, except trifling tonnage duties, about 2*d.* a ton to Southwold, if the ship goes beyond the limits of the port. I mention that to show the imperfections of the Bill.

1219. (*Chairman.*) Would you recommend that the limits of the port of Southwold should be altered?—Yes; they are now undefined, and we suffer in our own trade, from the limits not being properly defined. There is a coal trade carried on in Dunwich, within three miles of Southwold, and the coal merchants pay no dues, and compete with the Southwold and Halesworth merchants who pay dues, and thereby a great part of the revenue is lost. I believe on the Benacre side, to the north-east, there have been coals landed also.

1220. (Mr. *Hume.*) Do coal vessels go to those places to avoid the dues, or because they have not water to come into the harbour?—To avoid the dues.

1221. Could they come into the harbour?—Yes, they have come into the harbour, and taken shelter there, and then gone out and discharged. I believe that is the case to the best of my recollection, I should not like to state that positively as a fact.

1222. Have you complained of the embankments to any other authorities than the Commissioners and the House of Commons?—I complained to the House of Lords.

1223. Have you reported them to the Admiralty?—I have, and to the Woods and Forests, and Board of Trade.

1224. Have you taken every means in your power, to remedy, what you consider, an evil, by applying to such public bodies as you thought would take cognizance of those points?—Every constitutional means; but I have not used main force, as employed at Rye in 1830, whereby they gained their object.

1225. You complain of the expenses being high, have any books of account of the receipts and expenditure been given to you?—I have never been able to see the proper books which the Act requires, and I have never been able to check the accounts.

1226. What does the Act require?—Section 24 of the Act requires a book to be kept, "in which are to be entered true and regular accounts of all sums of money received, paid, laid out and expended, and the several matters and things, together with the quantities and prices thereof respectively," that clause was drawn up in my handwriting.

1227. Were those books to be accessible to any parties paying the rates or not?—Those books, upon the payment of a fee, are required to be shown, and copies to be given to any person in anywise interested.

1228. Have you, or any other person, applied to see those books?—I have applied to inspect the books, and to get copies continually since 1827, and I have not obtained any books such as the Act requires.

1229. Have the accounts been printed or published by the Commissioners in any of the newspapers?—I am not aware that they have.

1230. Have you, as a merchant, paying upwards of 300*l.* a-year towards those revenues, had access to books in order to ascertain whether the credits were proper and the expenditure regularly entered?—I have not, because those accounts are lumped; the sums are put in without quantity or price, which the Act requires.

1231. Where did you see those accounts?—They are here. I got them from the treasurer. I first went to the collector, Mr. Ellis, and then I went to the treasurer by his reference, and these are all the accounts that I have been able to obtain. (*The Witness laid on the table several annual accounts.*)

1232. (*Chairman.*) Did you ever apply to inspect the accounts which the Act required them to keep?—Repeatedly.

1233. Were you refused?—They told me that those were all the accounts they had.

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1234. Was there a book kept?—They told me that such a book is not kept.

1235. You are aware of the 26th Section of the Act, which, in the first place, directs the Commissioners to keep a book, and in the next place directs "That it should be open for the inspection of the said Commissioners, or any creditor or creditors, or any person or persons in any way interested, upon the payment of one shilling?"—There are two clauses respecting accounts; one clause is a general clause, and the other clause is the clause I read.

1236. What are the clauses?—The first is the 4 Geo. IV. cap. 48, s. 14, that provides for the annual meeting of the Commissioners, and at that annual meeting they are to state the whole transactions "to the intent that the account so stated may be open to the general inspection and examination of all persons interested therein, who shall assemble themselves at such annual meeting." I once applied for admission, and there was some difficulty about it. I was admitted to the meeting as a matter of courtesy, I understood, and I therefore never went again. I would not attend by courtesy.

1237. (Mr. *Hume.*) Did you ever present yourself at any of those annual meetings, and were you refused?—I presented myself in the year 1840, and wrote a respectful letter asking to be admitted, and I was admitted then, but I understood by the address that I got, it was by courtesy, as it would be inconvenient to let many people come.

1238. You did not apply in any subsequent year to be admitted?—No, I did not, because I thought it was not the proper way to go.

1239. (*Chairman.*) Did you consider yourself entitled under the Act to attend?—I did, but the only way, and that is the hardship of the case, would have been to go to law.

1240. (Mr. *Hume.*) Have you any observations to make upon those accounts which you obtained from the treasurer?—The following is the account of 1843; the first charge is "for labour, &c. as per surveyor's book, 500*l.*"

An Abstract of the Account of Mr. Joseph Berry Edwards, the Treasurer to the Commissioners of Southwold Harbour, for the year ending 24th June, 1843, audited quarterly by a Committee appointed for such purpose.

RECEIPTS.

		£.	s.	d.
1842-3.	Dues on 10,636 tons 9½ cwt. of coals at 1*s.* 2*d.*	620	9	8
	Do. on 19,184½ qrs. of corn at 2*d.*	159	17	5
	Do. on goods, &c.	117	6	6
	Do. on 1846 tons of ballast	68	19	6
	Tonnage dues	1	11	10
		968	4	11
1843,	Blyth Commissioners, proportion of survey	87	9	8
June 24,	Balance due to treasurer	90	17	6
		£1146	12	1

EXPENDITURE.

		£.	s.	d.
1842 June 24,	Balance due to Treasurer	149	19	0
1842-3,	For iron and blacksmith's work, &c.	24	16	5
	Labour, &c., as per surveyor's book	500	0	0
	Interest on money borrowed	53	6	5
	Salaries and law expenses	178	14	7
	Timber, &c.	2	10	0
	Rope, yarn, oil, pitch, &c.	11	0	4
	Rent of office	10	0	0
	Stamps, printing, and advertisements	8	19	0
	Miscellaneous	7	6	4
	—Walker, Esq., on account of survey	200	0	0
		£1146	12	1

The foregoing account was submitted to the Commissioners, assembled at their Annual Meeting, at the Old Swan Inn, Southwold, the 15th day of July, 1843.

COUNTERSIGNED.
HARRY WHITE, Clerk.

SIGNED.
STRADBROKE, Chairman.

1241. Did you ever apply to see the surveyor's book?—I applied to see the book that is ordered to be kept by the Act, and the only book I could see was, I believe, a transcript of this account. I also applied to see the minute book, that I might prepare myself for attending the Tidal Harbour Commission, and Mr. Ellis said that he could not show it me.

1242. At what time did you apply?—About a month or six weeks ago.

1243. In writing, or personally?—Personally; I think I am entitled to see every minute to know how my money is expended.

1244. Is that printed abstract which you have produced all that you have ever seen connected with the accounts of that year?—It is, except the book of which I believe this is a copy, so far as my remembrance goes.

1245. Do you know whether any other merchants have seen it?—I cannot answer that, but if you will allow me to show the insignificance of the timber, which is a material charge, the timber is only 2*l.* 10*s.*; Mr. Walker's survey costs somewhere about 500*l.*, and there are 200*l.* here paid; the next large sum is "Salaries and Law Expences, 178*l.* 14*s.* 7*d.*," and "Rent of Office, 10*l.*" Those I consider excessive, and far beyond anything we know of at any other port along the coast.—(*See Appendix* for Abstract of 1842, which contains the cost for timber used in 1843.)

1246. Is there any provision for auditors being appointed?—They are appointed by the Commissioners themselves.

1247. Have the accounts of which you have an abstract in your hand ever been discussed or considered at any public meeting of the Commissioners held under the Act?—I am not aware that they have been discussed. Mr. Ellis will answer that; the meeting is held with closed doors, and nobody gets in but themselves.

1248. (*Chairman.*) Did you ever apply for permission to take copies or extracts from the book or books kept by the Commissioners?—I have, but the book does not exist; I asked only six weeks ago to see it.

1249. Do you mean that they keep no books?—I do not know what books they keep; they know that themselves, but they said they could not show me such a book, nor any other than that they had shown.—(*See Appendix*, p. 167—Return of Books kept.)

1250. You described the book in the terms of the Act?—I think I took the Act in my hand.

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1251. (Mr. *Hume.*) You have stated that whilst in the Tay dredging costs only 2¼d. a ton, at Southwold it has cost nearly a shilling, including all expenses?—Yes.

1252. How do you come to that conclusion?—In the year 1840, from a conversation which occurred at the Commissioners' table at the annual meeting, where I was admitted by courtesy, I gathered enough to make out that it was nearly a shilling.

1253. Have you any other data upon which to form that opinion?—No.

1254. You have stated that the harbour of Southwold has been injured in the trade in corn? —Yes.

1255. Has it been injured, also, in the trade of coals?—Yes.

1256. Have any higher freights been taken for coals for Southwold, than for the adjoining port?—Yes.

1257. What do you pay?—We pay frequently 1*s.* to 2*s.* a ton more than Yarmouth, on account of the state of the harbour; sometimes we can freight ships for the same money, and at other times, when the trade is brisk, we cannot. At Southwold, the harbour dues are 1*s.* 2*d.* per ton on coals; at Yarmouth, 6*d.* per ton: on corn, 2*d.* per quarter; at Yarmouth, 1*d.* per quarter. The freight on malt from Southwold to London is 13*s.* per last; from Yarmouth to London, it is 10*s.* per last.

1258. What proof have you that that takes place?—When they have been paying a certain freight at Yarmouth for coals, we have paid more in Southwold, generally, but not always.

1259. You say Mr. Catt is a brewer, and can corroborate that statement of yours as to the injury which the harbour has gradually received?—Yes, and he can state the injury that was done to certain cargoes which were shipped for him.

1260. (*Capt. Washington.*) You have stated in your evidence that a large surface of land has been embanked which does not appear in Mr. Walker's, or any other survey; will you point out on the map where the spot is?—It lies to the westward of Wolsey Bridge.

1261. What is the extent of it?—I cannot say the number of acres, it may be from 200 to 400 acres.

1262. When was that embanked?—There is a traditional story that it must have been embanked in Cardinal Wolsey's time.

1263. Have you reason to believe that that marsh is below the present surface of the river at spring tides?—According to my judgment it is.

1264. (Mr. *Hume.*) Have the Commissioners of either navigation ordered any inclosures that have been made to be removed?—There has been no inclosure of this marsh land ever ordered to be removed, or ever attempted to be removed, by order of the Commissioners, so far as I know.

1265. Has any other impediment been ordered to be removed by the Commissioners?—The only case I recollect is contained in the following minute, which I request permission to hand in:—

"At a meeting of the Commissioners of the River Blyth, held at the White Hart Inn, Blythburgh, on Tuesday, 17th July, 1838, (amongst others,) the following minute was passed, viz.—

> "No. 6.—'The attention of the meeting was called to the encroachments Mr. Stead appears to have made [by the side of the river] in marking his boundary round his new malt offices, whereupon it was resolved that such encroachments be removed under the direction of the Committee.'

"(Signed) STRADBROKE.
"(Signed) HARRY WHITE."

1266. Is there anything besides that which has been ordered to be removed?—To the best of my knowledge nothing besides; but there has been some dredging of the river and cuts made by the River Commissioners up above Blythbro' Bridge.

1267. *Chairman.* Are you aware that an examination of the Port of Southwold and the River Blyth has been lately made by the order of the Board of Admiralty?—I am; I had a letter from the Admiralty, informing me that they would investigate the statements contained in my three letters of the 24th April, 8th May, and 28th June, relative to Southwold Harbour, and Captain Washington came down in consequence of these letters; the moment he arrived he applied to the mayor of the town, and he went immediately to the Town Hall; he said, "We must have this inquiry public, and every person is at liberty to come to it;" and he invited whatever evidence any party might have to bring forward relative to the subject of the former and present state of the river, the harbour, and the bar.

1268. (Mr. *Hume.*) Were you present?—I was.

1269. Did that meeting of the inhabitants take place?—It did.

1270. Were statements made in your presence by the inhabitants to Captain Washington? —There were.

1271. Have you seen the report?—I have.

[*The Witness withdrew.*]

William Catt, Esq.

William Catt, Esq., of Brighton, sworn and examined.

1272. (*Chairman.*) What is your profession and place of residence?—I am now out of business; I reside at 80, West-street, Brighton. For several years previous to 1844, I was the acting partner in the house of Vallance, Catt, and Company, of Brighton, brewers, maltsters, and ship-owners.

1273. Did you ever send any ships to Southwold?—We did not send ships to Southwold, but we were in the practice of having barley shipped from there for several years up to about the year 1838.

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1274. Have you suffered any loss in so trading which you have attributed to the state of Southwold Harbour or Bar?—Yes, I have. At the end of the year 1837, we ordered a cargo of barley from Mr. Stead; he shipped it in a vessel called "The Brother's Friend." On the 1st of January, 1838, the bill of lading and the invoice was forwarded to us. We heard nothing of the sailing of the vessel, and on two or three occasions, we wrote to urge Mr. Stead to prevail on the captain to proceed to sea. On the 12th of March, 1838, we received intelligence that the "Brother's Friend" had taken damage in proceeding to sea. I, at once, by permission of the under writers, or at their request more properly, proceeded to Southwold, and there I found that the "Brother's Friend" had got upon the bar and had stranded; the agent there had commenced to discharge her, and on taking the cargo out in lighters, they got the vessel back again into the harbour. She was then discharged, and after the lapse of some time the cargo was re-shipped, and we received it at the end of May. Perhaps I should say that the malting season terminates generally at the end of April, and the length of time that this vessel was detained at Southwold, and the unfortunate circumstance, determined us to have no more transactions at Southwold. We wrote a letter to Mr. Stead, to the effect, that although we had the highest respect for him and his dealings, yet from the unfortunate detention of vessels, owing to the bad state of Southwold Bar, we could not have any barley from him, and from that period till I retired from business in September, 1843, we had no connection whatever with Southwold; although, the following malting season we imported nearly 10,000 quarters of barley, principally from Norfolk.

William Blanden, sworn and examined.

William Blanden

1275. (*Chairman.*) Where do you live?—I live at Halesworth, in Suffolk, and go from Halesworth to Southwold in my wherry.

1276. How many years have you done so?—Sixty-four; going backwards and forwards.

1277. How old are you?—Seventy-six.

1278. What is your opinion of the state of Southwold Harbour now, as compared with what it was when you were a young man?—I think the reason why the harbour is so bad is their stopping so much back-water; there were 500 or 600 acres of channel which the water used to cover, and now they have stopped it all up—sea-walled it all in.

1279. What embankment do you refer to?—There are some as high as five or six miles, and some are not above two miles up the river.

1280. How many embankments have you known made in your time?—I have known them embank 500 acres; there was not any embankments when I first went upon the river. I have gone over the marsh, now embanked, in my wherry.

1281. Tell us the marsh which you know to have been embanked in your time?—Bulchamp Marsh, that is above Blythborough Bridge.

1282. Are there any others?—Blythborough and Bulchamp Saltings.

1283. (*Capt. Washington.*) Are you sure that you remember the embankment being made at Bulchamp?—Yes, I am certain of it.

1284. (*Chairman.*) Is the current of the river less rapid now than it was when you were a young man?—A great deal; when there was a good deal of water, going back on the ebb tide, there used to be a great current run out; there were great creeks half as big as the river. I have been up many times in my wherry, and the current used to be a wonderful deal stronger, and the harbour a good deal better, than it is now.

1285. Are those creeks stopped up now?—Yes; they stopped them up when they made the embankments.

1286. Were you a pilot into Southwold Harbour?—No, never. I have gone up and down the river from Halesworth to Southwold for 64 years.

1287. But not going out to sea?—Sometimes I have gone to sea to lighten a vessel in.

1288. Do you remember larger vessels coming into Southwold than can get in now?—I have known vessels of nine feet and nine feet and a-half come in, and I have known them come in at half-flood; and now they can hardly come in at high water. There was a ship of Mr. Stead's, the other day, lay there two tides; she drew nine feet of water, and the tides were good springs too.

1289. (Mr. *Hume.*) But has anything particular happened at the mouth of the harbour from the rise of the bar?—No, there was never back-water enough to scour it out; it wants a good deal of back-water to scour it out at low water.

1290. Formerly, where did the vessels load?—At Reydon Quay.

1291. How many miles is that above the mouth of the harbour?—Not above one mile and a quarter.

1292. Can any vessels come there now?—Yes, we have vessels there now.

1293. But not drawing the same depth of water?—Yes, they will draw the same depth of water in going up there; the bar is the difficulty.

1294. How high does the tide flow up the Blyth River?—We reckon it to be about eight or nine miles.

1295. Have any locks or impediments in your time been thrown across to stop the flow of the tide?—No; we have the Bulchamp and Blyford Locks, after passing Bulchamp House.

1296. Does the tide flow above Bulchamp Lock?—No.

1297. If the lock was removed, would the tide flow above that?—No.

1298. Do you mean that the tide flows up by the old channel, although it is stopped from the new canal at the Bulchamp Lock?—Yes; at the Bulchamp Lock it is stopped.

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1299. Are we to understand you to say that, in your recollection, the wherries and craft used to sail over the spots that are now enclosed as marsh land?—I have known one marsh that used to be under water at Bulcbamp House 2 feet. I have known the craft come there; but they cannot get under the foot of the bridge.

1300. Is Blythborough Bridge any impediment to your going up and down the river?—It is; it is too low; the craft cannot get under it.

1301. At half tide can they get up?—Yes, at half tide up to the staunch; but sometimes they lie there for a day; they cannot get in, because there is no flow of water up the canal. There is not the flow of water now that there used to be.

1302. Did you know a vessel called the "Old Drop" within the harbour?—Yes.

1303. When was that built, and for what purpose?—It was built for the purpose of lightering the ships out and in.

1304. Is that used now?—No; she is broken up.

1305. When was she broken up?—I do not know; it was there when Lieut. Ellis first came as harbour surveyor.

1306. Was the "Old Drop" built in order to facilitate the lightering of vessels?—She used to go out to lighter vessels when they came up; but it is some years since she was used. I do not suppose that she has gone out for 20 years. When the harbour got bad from marshes having been embanked, and when the larger ships could not get in; but when the south pier was carried out, the harbour improved, and the "Old Drop" was not then required, but was used as a "Dideler" [dredger.]

1307. If you had a similar vessel now, would vessels be able to pass the bar as they did formerly?—If it were to go and take the cargo out they might come in; but they cannot without. Since those banks have been made this "Old Drop" came on the river.

1308. Is it your opinion that the enclosing of those marshes has injured your harbour?—That is my opinion; that is what has done it.

1309. (*Capt. Washington.*) Has not the lower part of the river in the Harbour of Southwold been much improved by dredging and straightening by the present harbour surveyor since the year 1830?—Yes, it has.

1310. When was Blythborough Bridge built?—I do not know.

1311. Was there more or less detention of wherries passing up and down the river formerly than there is now?—There was less detention than there is now.

[*The Witness withdrew.*]

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Lieut. Francis Wilson Ellis, R.N., sworn and examined.

1312. (*Chairman.*) You have heard the evidence given by Mr. Stead, of Halesworth?—I have.

1313. Will you be so good as to make any observations which you wish to make upon it?—If you will permit me, I will first go into the state of the harbour formerly as compared with what it is now, and show by documentary evidence that it was as bad centuries ago, and as much complained of, as at the present moment. The first authority I will quote from is Gardner's History of Dunwich and Southwold. At page 40 it is thus written:—"Notwithstanding, on the 14th day of January, 1328, the harbour was utterly choked up by the north-east and east-north-east winds, and for the recovery thereof all means proved ineffectual. In a short time after, by pressure of the great quantity of water pent up by the stoppage of the old haven's mouth, a new one broke out near two miles further northwards, which was likewise stopped about the beginning of the reign of King Henry the Fourth. Another was cut that, having on the south-east point thereof a strong bank of ooze, continued to the year 1464; but then this bank being washed away, the mouth was often altering. It is noted that although the north-east winds are wonted to turn the shingle upon the mouths of their havens from time to time, as doth daily appear, yet this last haven was fortified at the south-east point with such a bank of ooze as did turn back the said shingle again at the stay of such rages, as appeared divers times since the same haven was opened. A fourth, called Hummerston's Cut, was dug out near the last-mentioned; but this was often choked by means of a sand lying north-east near the mouth thereof, and very noxious to ships sailing in or out." * * "This haven being destitute of some means to secure the mouth thereof, was often stopped, and continued almost useless from the year 1614 to the year 1618, whereupon the bailiffs of Southwold sued the men of Walberswick concerning the haven and flats; from which time it hath been subject (by the violence of the out winds) to alterations."

This next paragraph refers to the year 1609. This is collected from the Harleian Miscellany; it is taken out of Wake's History of Southwold:—"This town of Southwold, of a sea-coast town, is the most beneficial unto his Majesty of all the towns in England, by reason all their trade is unto Iceland for lings, and his Majesty's serjeant-cater hath yearly gratis out of every ship and bark 100 of the choicest and fairest lings, which are worth more than ten pounds the hundred, and they call them composition fish. But these men of this place are greatly hindered, and in a manner undone, by reason their haven is so bad and in a manner often stopped up with beach and shingle stone that the wind and the tide and the sea do beat thither, so that many tides in the season, when they be ready to go to sea, they cannot get out when time is to go to sea, neither can they get in when they return from sea, but oftentimes do cast away their goods and themselves. This haven, if that it had but a south pier built of timber, would be a far better haven than Yarmouth haven, with one quarter of the cost that hath been bestowed on Yarmouth haven. They are now suitors unto his Majesty. God grant they may speed, for it is pitiful the trouble and damage that all the men of these towns do daily sustain by their naughty harbour."

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I now come to June, 1747, and I produce the Minute Book of the Commissioners from the time they obtained their first Act of Parliament. I find this Minute:—"That it appears to us that the reason why the haven hath been stopped up is more for want of a good foundation under the old piers." And then, on the 5th day of July, 1748, "We do hereby agree that, if the said port or haven shall be choked or stopped by sands, or otherwise, the present Bailiffs, Master William Lenny, and three of the Commissioners named in the said Act, or any two of them, shall have power and authority to cleanse or open the said haven, and that Mr. John Smith, collector of the said duties, shall pay for the same." In Magg's Hand Book of the Port of Southwold I find, in page 9, "It has been already observed that, about 1618, the Bailiffs of Southwold assumed the superintendence of the haven, and it is beyond a question that, after the lapse of a very few years, they adopted it as their own; the Corporation being, for the most part, at the expense of maintaining it. The Corporation, however, are possessed of no accounts previous to 1661, and it is not until 1680 that the accounts contain anything specific as to the charges of the haven. From that year, however, it appears to have been a constant annual, but not great charge; but, in 1714, the charge of 'digging and making a new haven' was 37*l.* 10*s.* 11¼*d.*, at which time it appears that the annual income of the Corporation did not amount to 100*l.* Therefore, in 1723, when it became expedient 'to stop the haven, and to make a new one,' a deputation was appointed, at an assembly of the Corporation held on 21st of February, to collect 'aid from the gentlemen in the country.'" At the period we are speaking of, "the haven was fixed to no certain spot, but was occasionally to be found opening on various points of the compass, from the north-east to the south-west, under the control, as it would appear, of the wind; as, when the wind was sufficiently strong from the north-east to raise a sea, the channel from the river opened into the south-west, and, when the wind from the south-west was strong enough to raise a sea from that quarter, the channel opened into the north-east; when the wind was north-west, with a smooth sea, it opened into the south-east. In these changes the channel sometimes opened as much as 400 yards to the north-east of the present north pier, running inland, not far from the present road leading to the present haven; and, at other times, the channel ran to the southward as far as the post called Sir Charles's post, perhaps about 400 yards south-west of the present south pier." This shows how the bar is formed. It is identical with the state of the bar at the present time.

1314. (Mr. *Hume.*) You have read two minutes of 1747 and 1748, in which it appears that the Commissioners of that time authorised the Committee under whose direction the harbour was, to cleanse it out; are there in that minute book any further minutes respecting the state of the harbour?—There are a great many minutes respecting the state of the harbour, the works to be done, the extension of the piers, and various matters of that kind, but I do not, up to the period when I went to Southwold, find any particular entries as to the date at which the harbour was choked up, but I find in Magg's Hand-book, that between 1805 and 1818 it was dug out 13 times.

1315. (*Capt. Washington.*) But will not the accounts show it?—Yes, but I have not the accounts, they are in another department, the Treasurer's.

1316. (Mr. *Hume.*) Do you keep the minute-book?—No. I am not clerk of the Trustees. I am harbour surveyor and harbour collector.

1317. What further minutes are there in that hook respecting the harbour, and are there any sanctioning any embankments on the sides of the river?—There are two minute-books down to the present time, I have seen no reference whatever to embankments in the minute-books.

1318. Are there entries of complaints against embankments?—None, that I am aware of.

1319. Then in the books you have no proofs or traces as regards either embankments or complaints against embankments?—No, the complaints that have been made are entered in this book, but there are no complaints of embankments till within about the last 15 years, till Mr. Stead came to Southwold. The embankments were most of them made before there was any Harbour Act.

1320. (*Chairman.*) Were you the harbour surveyor in 1830?—I was.

1321. What, in your opinion, was the state of the harbour in 1830?—The state of the harbour has been very much improved since 1830; in 1829, the year that I was appointed, when I went to Southwold the harbour was in a very bad state, arising from the banks in the interior of the harbour.

1322. Explain what those banks were?—The Bellar Shoal ran across the lower part of the harbour. There was insufficient water for the vessels to go up or down the river, in consequence of the shoals in the main channel; the Bellar Shoal was cut through by a steam dredger in 1833, and the shoals were cleared away as far up as they existed, which was nearly to Black Shore Quay.

1323. What distance is that?—Nearly a mile, the consequence was that the harbour which was frequently blocked up previously, went ten years without closing up; the closing up had been more frequent in previous years.

1324. (Mr. *Hume.*) In what way did the clearing of the shoals tend to keep the bar open?—In consequence of the unopposed force of the water coming down the river upon the bar, and not being obstructed by the Bellar and other shoals.

1325. (*Chairman.*) From 1830 to 1840 the harbour was not blocked up?—To 1839, I should say nine years.

1326. (Mr. *Hume.*) What other works have been carried on by the Commissioners?—The piers have been very much repaired, part of them rebuilt. The jetty which existed at the lower part of the harbour has been removed, and a skeleton quay constructed near Blackshore. Vessels now, instead of loading or unloading at the old jetty, go to Blackshore and Reydon Quays, which they were unable to do before.

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1327. Is it your opinion that the deepening of the river by dredging, as stated by you, admitted a greater flow of tide, and by its effect tended to sweep the bar?—I do not know that it admitted a greater flow, but I think it has that tendency. It admitted a larger body of water.

1328. Do you mean that the fresh coming with greater force, and more directly upon the shingle which formed the bar, tended to keep it open?—Yes.

1329. Can you remove any impediments now existing to the flow of the tide up?—There are no impediments in the lower part of the harbour, but if the channel of the navigation above was dredged and cleaned out, a much greater body of water would be admitted into the river, which would very materially and essentially improve the bar.

1330. Are you aware that on the banks of that river, enclosures of land formerly covered by the tidal water have been made?—Of my own knowledge I know nothing, but from general statements, and the reports of Mr. Walker and Mr. Rennie, I presume that to be so.

1331. Do not those enclosures interrupt the flow of the tide upwards, in the same manner as the banks which you have removed from the lower harbour did?—I apprehend not.

1332. Do you say that the enclosures of those lands on both sides of the river, have not been an impediment to the flow of the tide?—Certainly not, in my opinion.

1333. It has been stated to the Board, that some of the marsh lands were formerly covered with water approaching to three feet deep, and that they are now dry, is the opinion you have given consistent with that fact?—I will endeavour to explain it. By confining the water in the channel of the navigation, we obtain a greater depth than if it was allowed to expand itself over a larger area.

1334. If it was allowed to expand itself over a larger area, so as to admit of a larger quantity, would not the power of that efflux be far stronger than it is now, by being kept to the channel?—I do not think that there would be a larger body of water come in if the embankments were removed; and I will assign as a reason for my opinion, if you will allow me to refer to it, Mr. Langley Edward's Report, who surveyed the river in the year 1757. You will find that in that year he says, "At Blythborough Bridge the tide flows into the said river from Southwold Haven through the bridge, and waxes five feet there at common spring tides." In Mr. Rennie's Report he also says, "The average rise of the water there," that is at Blythborough Bridge, "is about five feet, and the tides used to cover them about six inches." Mr. Walker, in his Report of 1841 (*see App.* p. 170), gives a rise of six feet and a-half at the same spot. Consequently it appears from those documents, if they are any authority, that at the present day there is a foot and a-half more rise of water there than there was formerly.

1335. Since Mr. Edwards's survey have you not dredged the river and removed the shoals?—Yes, in the harbour.

1336. Then by that means you have admitted a larger quantity of water?—I suppose so.

1337. That will, in part, account for the increase?—No doubt it has a tendency to improve the navigation.

1338. If other impediments were in the same way removed would not that also further improve the navigation?—Certainly.

1339. (Mr. *Rice.*) The impediment is in the bed of the river?—Yes.

1340. Therefore that is a facility to the flow of the tide, it has not increased the reservoir?—If you get six feet and a half instead of five feet you increase the reservoir; I mean to say that the water being shut out from those lands, and confined in the channel of the river, tends to increase its height, and I am fortified in that opinion by Mr. Rendel. (*See App.* p. 175.) I will state further, that there are two creeks, Buss Creek and Wolsey Creek, mudded up, and which are not at all affected by the embankments that have taken place above.

1341. (Mr. *Hume.*) In as far as the tide cannot flow up those creeks now, the quantity of water on the ebb must be diminished?—Yes, and on the flood also.

1342. Then, would it not tend to improve the harbour if you had those creeks deepened as well as the parts that you have now deepened?—Unquestionably; but I instanced them to show that the embankments are not the cause of the river silting up as much as it has done. Buss Creek I find, in Gardner, was formerly large enough to contain 150 fishing vessels.

1343. You are of opinion that the improvement of Southwold Harbour would be promoted by deepening and removing the silt from all those tributary channels and creeks?—Yes, precisely so.

1344. Is it your opinion that you would facilitate the improvement by admitting in every possible way the ready influx of the tide?—Unquestionably; we should obtain in consequence a greater momentum of water, which is what we want; we have an insufficient supply of fresh water and that is one reason why those creeks have been choked up. The Buss Creek is now hardly deep enough to float a boat, and not being affected by the embankments, I draw the conclusion that there is a tendency for the navigation to choke up for want of some artificial aid in the interior of the navigation.

1345. To what do you attribute the difficulty which took place at the bar in 1839?—Entirely to the east and north-east winds.

1346. There is not natural water enough to sweep away the banks that are formed by the easterly gales?—The harbour blocks up during the east and north-east winds from the great quantity of shingle which comes along the coast, which meets with an impediment at the piers, and there forms itself into a bank; it comes in upon the flood tide, and before high water, closes the channel to such a narrow compass that when the ebb comes it has not power to keep it open.

1347. (*Capt. Beaufort.*) Which way does this shingle come?—From the northward.

1348. (Mr. *Rice.*) You stated that you were fortified in the opinion which you have now expressed by Mr. Rendel's opinion, when, and in what way, was Mr. Rendel's opinion expressed?—In answer to the queries of the Earl of Stradbroke. I have many sketches in these

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books which I now produce of the position of the harbour's mouth, and which show how the bar has been affected by the different winds.

1349. (*Chairman.*) By the Act of 1830, Commissioners were appointed for the improvement of the harbour of Southwold ?—Yes.

1350. Mr. Stead complains that he has not had access, agreeably to the terms of the Act, to the accounts, and that he has not seen more than a general abstract, not including any items; what observations have you to make upon that ?—I have to state in reply that the Treasurer is the appointed officer for keeping the accounts, in accordance with the 26th section of the Act, and I consider that the accounts of Southwold Harbour are kept in a perfectly regular and proper manner. The Commissioners have a quarterly audit of the accounts, in which every item is sifted and every expenditure looked into, and these books are signed quarterly by the managing Committee. According to the Act of Parliament, an abstract of the year's accounts is made up at the annual meeting, and published for general information. I now produce and put in the printed Annual Abstract of the accounts as required by the Act of Parliament from the year 1836 down to the present time.

1351. Those abstracts are taken from the book kept in pursuance of the 26th section of the Act?—They are made in pursuance of the 14th section.

1352. Are there books of account kept in compliance with the 26th section ?—That book is kept by the Treasurer, then there are supplementary accounts which I render; there is the collector's account for the collection of the revenues, and the surveyor's account which includes the weekly labour and the dredging; the surveyor's book is kept as a receipt and expenditure book. Mr. Stead has never applied to me for an inspection of it or of the collector's book. About a month ago, when he was coming to London, he applied to me for some documents which I did not feel at liberty to furnish him with, and also for an inspection of the minute book.

1353. Were there not some petitions which he had presented to the Commissioners, or some letters which be applied for ?—Yes; and also the minute book, which he had no claim to see; and when I declined to furnish him with that inspection, he then asked for the accounts. I asked him what accounts he wanted, and he said, the accounts of the general expenditure; and I referred him to the Treasurer's book which is kept under the 26th section of the Act, and which is open to the inspection of all the payers of dues.

1354. All this you state from your own knowledge ?—I do.

1355. Is the work performed at Southwold publicly contracted for ?—The materials are advertised for by contract when required for repairs of any extent; when there is any new pier work to the extent of 40 or 50 feet, the materials are advertised for by public contract.

1356. How is the dredging done ?—The first dredging was performed by the Commissioners' own steam dredger, but they advertised for parties to contract for the work, that is, supply the wherries and labour; that contract was taken at 4½*d.* per ton by the late Mr. Godfrey Goddard, that was in 1833: that dredger worked for three years at that contract price, when the harbour being completely opened out, and a debt having been contracted by the undertaking, which was a very gigantic one for a harbour with so small a revenue, the dredger was sold, and the money appropriated to the liquidation of the debt. In 1839, when the harbour, by a long succession of north-east winds, became bad again, the Lowestoff dredger was hired, and then the contract for wherries, and the work was taken by Mr. Clarke, of Yarmouth, at 5¾*d.* per ton. That was done by public contract. I have the advertisements here, and I should wish to produce them, because it has been asserted that the contract was made without due advertisements.

1357. Where was the contract advertised ?—In three county papers, circulated in Norfolk and Suffolk. The contract was taken by Mr. Clarke, of Yarmouth, a gentleman who at the same time was under a contract at Yarmouth for the same purpose; his contract there was 5½*d.* per ton, and his contract at Southwold was 5¾*d.* per ton. Mr. Stead has said that at the Tay a contract was done at 2¼*d.* per ton, and might have been done as cheaply at Southwold, and therefore I wish to show that in a port near Southwold, viz., at Yarmouth, the contract was only a farthing a ton different; and when the contract was made Mr. Clarke stated to the Commissioners that his contract at Southwold was much less advantageous to him than his contract at Yarmouth for various reasons, one of which was, that he had to send wherries from Yarmouth at great risk and expense. I will, with the permission of this Commission, put in the three advertisements for the contract which were published in the county papers. The contract at the Tay was for labour only, exclusive of wherries.

1358. By whom are the auditors chosen ?—By the Commissioners. There is a Committee of Commissioners appointed every year as a Committee of management, whose province it is to audit the accounts, and to look into every item of the expenditure.

1359. The Commissioners appoint the auditors ?—Yes, from themselves.

1360. How many ?—Seven.

1361. By the 6th section of the 11th of Geo. IV., the Commissioners of Southwold Harbour were empowered to elect five additional Commissioners, do you know whether any of these Commissioners were elected at the first meeting, or subsequently ?—The Earl of Stradbroke is one of those six. Lord Huntingfield is another appointed under that section. Mr. Reynolds, of Halesworth, is a third, and there are others that have been appointed, (but whether under that section or not, I cannot say,) for other vacancies have been filled up; all the justices of the peace are also Commissioners of Southwold Harbour. There are now three Commissioners of Halesworth, the fourth, Mr. Ringwood, is lately deceased; those three, and Mr. Lay, who lives in the neighbourhood, may be all considered as Commissioners from Halesworth, in the Southwold Commission; taking then the Halesworth quota at five, that town is more fully represented in the Commission than Southwold. The qualification tends to exclude merchants

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and ship-owners, there are very few, scarcely any qualified in either place, but every nautical man qualified is in the Commission. Of the River Blyth Commissioners, there are about 50, there are no *ex-officio* Commissioners, and there is no qualification to exclude; they are a self-elected body, yet though they complain that they are not represented in the Southwold Commission, they have only one person from Southwold in the Blyth Commission, and that is myself. With regard to the blame, if any, that may be imputable with respect to the embankments, they are all, with very little exception, within the jurisdiction of the Commissioners of the River Blyth, and the River Commissioners do nothing beyond making the channel navigable for wherries, consequently it is insufficient to be of any palpable benefit to the harbour. I do not think that the Southwold Commissioners have any power with respect to those embankments. Blythborough Bridge, of which the River Commissioners so much complain, is out of the jurisdiction of the Southwold Commissioners. Mr. Stead complains also of the salaries being very excessive, and he makes a comparison with Yarmouth, where the salaries of the pier-master and collector alone amount to 500*l.* I will state what the salaries are. For my own services as the principal executive officer, in which I perform the duties of harbour surveyor (and that of engineer as far as I am able, for I built them a steam dredger without any assistance), collector of the harbour dues, harbour master, clerk to the committees, and general secretary when the aid of writing is required, pilot-master, and rendering my assistance in every possible way upon all occasions, I receive a salary of 100*l.* a year, with an allowance of 10*l.* for an office, for which I have furnished the Commissioners with one of the best rooms in my house, completely fitted up as a harbour office. The treasurer's salary is 35*l.* a year, the deputy harbour-master 10*l.* a year, and the clerk's salary 13*l.* a year, making 168*l.*; that is the total amount of the salaries. Mr. Stead's observation of the defect in the Act, that vessels land their coals at Dunwich and other places, is correct, and can only be remedied by a fresh Act. Dunwich is a small place, and coals are landed there, the object being as much to save the harbour dues, as to get their coals close at hand; they save four miles of land-carriage over a bad road by landing their coals at the beach.

1362. (*Capt. Beaufort.*) Are you perfectly satisfied that the inquiry that was made at the port of Southwold, by order of the Admiralty in last year was a full, public, and impartial one?—Certainly; I was present at it; there was some evidence, that of Fisk, a wherryman, taken at Blythborough Bridge, and James Sterry, Deputy Harbour Master, which has not appeared here to-day, and which would contradict the evidence given by William Blanden. (*See Appendix.*)

1363. (*Capt. Washington.*) Do you admit the accuracy of Mr. James Walker's survey of, and report on, the River Blyth and Southwold harbour, made in the year 1841, as to facts?—Yes.

1364. You are aware that from that survey and report it resulted that at ordinary spring tides 150,000,000 cubic feet of water have been excluded from the river?—Yes, but I must be allowed to qualify my first answer; I think that his calculation is fallacious; I do not believe it to be the fact that 150,000,000 cubic feet of water are excluded.

1365. If, in addition to the dredging, deepening, and straightening the harbour, carried on under your superintendence, the additional flow of water stated by Mr. Walker had been admitted, would it not in your opinion, as a sailor and experienced harbour surveyor, have been very beneficial to the harbour and bar?—I think that Mr. Walker is in error in assuming that such a body of water has been excluded by the embankments, because it appears by his own report that there has been a foot and a half additional depth gained in the channel of the river, since the last of the embankments have been formed; he makes the flow to be 6½ feet, whereas Mr. Edwards and Mr. Rennie make it only 5 feet. Those embanked lands would have silted up ere this, had they remained open.

1366. At what place is the rise of tide said to be 5 feet?—At Blythborough Bridge.

1367. Have you read Mr. Rennie's Report, dated the 6th of January, 1830?—I have.

1368. Does he not distinctly state, "Good springs rise at Southwold Harbour 6 feet 6 inches, and the tides at Blythborough rise nearly as much as they do at Southwold?"—Those are his words; but he says before that, that the rise is 5 feet. Mr. Langley Edwards, in 1757, also states the rise at common spring tides to be 5 feet at Blythborough.

1369. You have stated that the Harbour Commissioners have no right to object to impediments or embankments in the River Blyth beyond their limits, do you mean to assert, to put an extreme case, that the River Commissioners might place a lock across the river, without the limits of the Harbour Commissioners, and so cut off the whole of the water of the river?—I did not state that they had no right to object, I stated that I did not think they had any power to interfere; that is, to pull down the embankments, it being out of their jurisdiction.

1370. Is not the volume of fresh water brought down by the River Blyth utterly insignificant?—Yes, excepting in wet seasons, when the scour on the ebb is materially assisted by the freshes.

1371. In the minutes of a meeting of the Blyth Commissioners, on the 17th of July, 1838, the 6th paragraph says, "The attention of the meeting was called to the encroachment [in the river] which Mr. Stead appears to have made in making his boundary round his new malt-houses, whereupon it was resolved that such encroachments be removed under the direction of the Committee," are you aware of that order having been given?—No.

1372. You admit the authenticity of this copy of the report of the proceedings which I now show you?—Quite so.

1373. Then it appears that although unresisted embankments to the extent of 1500 acres had been made upon the river, still that meeting decided to pull down an encroachment perhaps not 20 yards in extent?—Yes.

1374. Thereby admitting that the whole of the other embankments were illegal, and that

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they had power to order them to be removed?—Is there not some misapprehension? This is a document of the River Blyth Commissioners, and this embankment is at Halesworth; this never came before the Southwold Harbour Commissioners. They could have no jurisdiction nine miles up the river within the precincts of the River Blyth Commissioners.

1375. Is not the same person chairman of the Southwold Trust and the Halesworth and Blyth Trust?—I cannot say who is chairman of the River Commission; the chairmen are, I believe, elected on the day of meeting.

1376. Was not the same person chairman on that day who is usually the chairman of the Southwold Commissioners?—Yes.

1377. Is not the law for Southwold Harbour and the law for the River Blyth the same with respect to embankments, and also for all the rivers in the United Kingdom?—I should say that that is a question which hardly requires an answer from me. The law is the same throughout the United Kingdom of course; but as to the authorities which have been presented here by others, namely, the opinions of Judges, of Mr. Grose and Mr. Chitty, I think the cases are very wrongly stated, and I think that the cases quoted for the opinion of the Judges are not analogous.

1378. You are aware that I do not refer to any opinion of Judges, but to the Act of Parliament 46 Geo. III., c. 153?—I do not know of any Act which confers any power except that Act which passed in 1806; and I think that embankments in public rivers made subsequent to the passing of that Act, without the approbation of the Admiralty, are illegal. That is my individual opinion; but I think all other embankments have been sanctioned by time, and that it is now impossible that the possessors of them can be disturbed in their possession. I think some of the embankments on the sides of the river have been made for centuries, and that there is a prescriptive right to them. If you refer to the opinions of the Judges, I think you will find that prescriptive rights are excepted. I will state another circumstance: last Session a Bill was brought into Parliament called the Commons' Enclosure Bill, in which it was proposed to legalize all such embankments as had been made within 20 years. How then can any person come forward, as some have done in the present day, and talk of having grazing lands, which have been enclosed for centuries, restored?

1379. (*Capt. Beaufort.*) Have you considered what would be the best way of improving the harbour of Southwold?—I would follow out the improvements recommended by Mr. Walker, that is to widen and deepen the channel of the river, so as to make it navigable up to Bulchamp Lock, and to clear out the creeks by steam-dredging, by which means a great additional quantity of water would be brought in and out of the harbour, giving a greater momentum to the current, and thereby very much improve the bar. I think all extension of piers prejudicial, because Southwold Bar being a shifting bar you cannot throw out your piers to act upon a shifting bar as you would upon one which is more stationary.

The Southwold Harbour and the River Blyth Commissions should be merged into one Commission, and the limits of the port defined and made identical with the Customs' limits.

I would further suggest the constitution of a central Harbour Board in London, to have the supervision and control in the improvement and management of all the harbours in the United Kingdom, with Sub-Commissioners or local assistants of inspection, leaving to the local authorities the administration of local matters of detail; to have one General Harbour Act, so as to obtain more harmony of action, assimilating the constitution of the local Harbour Boards, the provisions and penalties, &c., as far as practicable, with a power vested in the Central Board to vary or alter according to circumstances; to have the regulation of pilots and pilotage; and to have annual returns made of revenue expenditure and all other matters and things relating to each harbour.

1380. If those means were adopted which you have been enumerating for the improvement of the harbour, what depth of water would you expect to get?—We have now in still weather, at high water, about 10 feet, and if those means were adopted, that depth would be greatly increased; it is hardly possible to say to what extent.

1381. At what rate of velocity do the spring tides enter your harbour?—They go out with greater velocity than they come in; our spring tides are about four knots an hour.

1382. (*Capt. Washington.*) Had not the Southwold Commissioners some plan for the improvement of the entrance from Mr. Calver, the master of the "Blazer"?—They had.

1383. And you approved of that plan?—Yes, upon general principles, it is the best that has been propounded; but Mr. Calver deprecates any extension of piers, and I think that the extension of sheet piling, such as he recommends, would have the evil effect of extended piers, unless a breakwater was constructed to the northward, to carry off the passing shingle into deep water. A copy of Mr. Calver's plan, with his report on the improvements of Southwold, is included in the returns now before this Commission.

1384. Is there any worm, such as the *teredo navalis*, in Southwold Harbour, which destroys timber?—Yes, a very powerful worm. I would make an observation with regard to the masters who gave their evidence before the River Blyth Commissioners; it is very conflicting. At the meeting of the Southwold Harbour Commissioners, when they received the evidence which the Commissioners of the River Blyth submitted to them, there was no attempt made to controvert what was submitted; the object was to receive all the evidence and suggestions that might be made for the improvement of the harbour; when they had so done, that evidence was submitted to Mr. Walker for his opinion, and upon that is founded the report of Mr. Walker. Some of these documents produced by Mr. Stead have never been before the Southwold Commissioners, and therefore, of course, they have not had an opportunity of answering them.

[*The Witness withdrew.*]

G. Stephenson, Esq.

May 28, 1845.

George Stephenson, Esq., Civil Engineer, sworn and examined.

1385. (*Chairman.*) You are engineer to the Whitehaven and Furness Junction Railroad?—I am.

1386. Will you state generally what is the line of that railroad?—The line goes along the coast from Whitehaven to St. Bees to Ravenglass, to Duddon Sands, and then across to Furness, forming a junction with the Furness and Piel Railway. The object is to get away the iron-stone; there is a large quantity of iron-stone worked in that neighbourhood and sent into various parts of England.

1387. Is it any part of that plan to cross Morecambe Bay?—No, not at present? we may have another project for crossing Morecambe Bay; there is no such plan in Parliament this year, but I dare say it may be next year.

1388. (Mr. *Godson.*) Would not this be a part of that railway?—It would.

1389. Is not the object of crossing the Duddon Sands and coming down to Ulverstone to form part of a railway to get into the Lancaster and Carlisle Railway?—It is; not only that, but there is a line to be brought before Parliament next Session to go into Yorkshire which will join at the same spot where we shall join the Lancaster and Carlisle Railway.

1390. At what place is that?—It is between Bolton and Milnthorpe; and then this other line will continue on by Skipton, and down to the eastern parts of Yorkshire.

1391. What length is the Furness and Piel Railway?—About six or seven miles.

1392. Is your object in crossing the Duddon Sands to join a new railway of only six or seven miles?—At present, it is, because that forms a communication to the Piel Harbour and from the Piel Harbour we expect to carry on the traffic to the Preston and Wyre Railway by steam boats. At present the vessels take up a good deal of iron at Piel, and we also mean to carry the iron round by Whitehaven, and thence down the Newcastle and Carlisle Railway to the iron works at Newcastle.

1393. But at present you do not purpose going further than the Furness and Piel Railway?—Certainly not.

1394. In what way do you mean to cross the Duddon Sands?—By an embankment.

1395. How long will that embankment be?—A mile and a quarter.

1396. How much of the navigable part of the Duddon water would you cut off?—I do not know the extent of it, the whole of the water above the embankment of course will be cut off. Probably about 5000 acres.

1397. How many miles is it from there to Broughton?—About four miles, but then we propose giving them a railway up to the same place instead of the navigation.

1398. Up to Broughton?—I do not know that we shall go up to Broughton, but we mean to make it as beneficial to that district as the navigation is at present. The railway does extend already some distance towards Broughton, we mean by continuing it further to give them the benefit of a railway not only to Piel but to Whitehaven. From Whitehaven, coals brought down to Broughton will be reduced one-half.

1399. How is the water of the river Duddon to get through?—I mean to make an outlet.

1400. (*Capt. Washington.*) Is that in the Bill?—No; we shall have to do it by private contract; we had it on our plan, but it was not given notice of. The way in which I mean to construct the embankment is this. I am quite aware that it is impossible to form an embankment in a place like this, if I were to make a common embankment. My reasons for saying it is impossible are these:—when the two embankments came near together, if I were to embank this in the common way, the current would be so strong that no material that I could put in there would stop, and it would be impossible to finish it. My plan is this: to go, as it were, by stealth; for instance, I would construct wooden bridges on piles to the height that the embankment is intended to be.

1401. How high above high-water mark?—Six feet. Then having constructed this wooden railway on piles, allowing the water to flow freely, as it has hitherto done, only obstructed by the piers, I fix a steam-engine on each bank of the river, and I draw the waggons across, to and fro, with a chain. Then when the material is dropped out, I keep it as nearly level as I possibly can, and shall keep a man to survey this every day, or the whole of the day, so as to give notice to those who have charge of the waggons where the lowest part is, that that may be kept up level with the other. I go on keeping it so till I bring it to the proper height. I allow the water to flow over. I am, in fact, merely making a mill dam. There can be no risk, providing they bring the material that shall not wash away. I shall bring craft, and pitch it in; then going on step by step, as I have stated, at last I prevent the tide from flowing over; then I carry it up to such a height that the waves will not affect the railway, and of course I finish. I do not believe that this water will stop up to the level of the embankment for many years. I think that in a great part of this new embankment it will ooze through; but, ultimately, I believe it will come quite level into the outlet, and another outlet will be made to carry off the land floods.

1402. (Mr. *Godson.*) In other words you mean a new channel for the river?—Yes.

1403. How deep is the sand upon which you are to throw in materials?—It has been bored, but I do not exactly recollect; it is not deep, I do not care what depth it is. I am confident that it would answer in the way I propose.

1404. What is to become of the bed of the river from the embankment up to the source?—It is to become land.

1405. Who claims it?—I believe the Crown claims a part, and Lord Lonsdale and Lord Burlington, and I believe the Duke of Buccleugh.

1406. Was there not a plan suggested some time ago for crossing Morecambe Bay?—Yes; that is a plan which I proposed some years ago; it was projected by some other person after me, Mr. Haigh, but his plan was very different from mine.

1407. But was not your plan to cross Morecambe Bay somewhere near Bolton, and then to go by Chapel Island, and to land by means of having a wooden railway above, and by dropping in stuff in the course of years to allow the sand to silt up against it, and by and by to make an embankment across the bay, taking care to lead the water of the river that runs into the bay in an artificial canal so as to come out nearer the sea into the bay again?—That I think was proposed by Mr. Haigh, that was not my plan. I do not think it could be done. In making out my Report, I stated to the Directors that though I believed it was practicable to embank in the way I have stated, it was too great a work for any Company to take up in my opinion without having Government assistance, and then the Directors published my report, but left that part out. My report was published with a view to raise money to do the work, but they left that out, and I then resigned my place, and they got Mr. Haigh.

1408. Would it not be useless to have a line to cross Duddon Sands, unless you had afterwards a line to cross Morecambe Bay?—No; it would not be so good a line to the public, without being carried forward over Morecambe Bay, but still it would be a line to Lancashire, by making use of steam-boats from Piel Harbour, going by the Preston and Wyre Railway.

1409. Is not then your object to get to the Preston and Wyre Railway?—Yes.

1410. Then one of your objects in crossing Duddon Sands is to get a communication to the Preston and Wyre Railway from Piel?—It is; I did not think that there was money to be got to carry the thing out when I recommended it to Lord Lonsdale and the Whitehaven people, therefore we stopped short after crossing the Duddon Sands. Before the Bill was granted for the greater work, I should like to accomplish this.

1411. But having accomplished this, you would make that a reason for asking for the next?—Certainly I would.

1412. (*Chairman.*) We have gathered from your previous answers, that it is intended to afford some communication to Broughton in the shape of a railway?—After hearing that there might be some complaint made, I stated that I thought we ought not to take any benefit from any district without giving them something as good.

1413. This is what is complained of from a party residing at Broughton Tower. "I beg leave to call the attention of the Lords Commissioners of the Admiralty to a Bill which is now before Parliament, for making a railway, to be called the Whitehaven and Furness Junction Railway, and which is intended in its course to cross the river Duddon, near the estuary thereof, (where it is of very considerable width) by means of a viaduct and extensive embankments, in order to join the Furness Railway, near Ireleth. The river Duddon is navigable to within two miles of this place, and affords the means of conveyance for coals and other sea-borne goods, at a very moderate rate of carriage, to the market town of Broughton, and the surrounding district. I am advised by persons of competent knowledge on the subject, that the effect of the proposed embankments and viaduct will be either to totally destroy the navigation of the river by preventing the passing of vessels laden with coal and other produce, or at all events greatly to impede and injure such navigation, and as this is a point of the first importance to the town and neighbourhood of Broughton, in which I am deeply interested, I take the liberty of appealing to the Board of Admiralty on the subject, in the hope that their Lordships will not consider such a matter wholly unworthy of their attention. I am hardly qualified to say in what way the evil in question can be obviated, supposing the proposed line to be adopted, but it has been suggested to me, that a swing bridge of competent dimensions might be thrown over the river, which would prevent the stoppage of the navigation, though I cannot presume to say how far the proposed embankments might affect the channel of the river?"—I should not think of proposing a swing bridge; the current of the water would be so great, that I think it would be unwise for any engineer to attempt such a thing.

1414. (Mr. *Godson*) You rely upon the silting up of the river by means of the materials that you would throw in?—Yes.

1415. (*Chairman.*) So far as the town of Broughton is concerned, you would be prepared to furnish them with good accommodation?—Yes, the Railway Company will be prepared to give them more benefit than they will take away from them.

1416. (*Capt. Beaufort.*) Could not you carry your railway up the right or west bank of the Duddon so as to cross from Shaw Point to Angerton?—It would carry the line so many miles round, that it ought not to be made at all. I would not make it.

1417. In what way would it carry it round; it would leave that line that is to join across the country to Leeds?—No, you could not cross that country; you could not get over the ground. There is no other way but to come to this place.

[*The Witness withdrew.*]

Adjourned till Friday next, at One o'clock.

Lord Advocate of Scotland.

May 30, 1845.

Friday, 30*th May*, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. BREMER, K.C.B.	Captain BEAUFORT, R.N.
Mr. HUME, M.P.	Mr. A. CHAPMAN, M.P.
Mr. GODSON, M.P.	Captain WASHINGTON, R.N.
Mr. RICE, M.P.	

Lord Advocate of Scotland called and examined.

1418. (*Chairman.*) You are Lord Advocate of Scotland?—Yes.

1419. Will you explain to the Commission what is the present state of the suit now pending between the Trustees of Montrose Harbour and Sir James Carnegie, Bart., on account of certain alleged encroachments?—I examined the papers in the case, and the view I take of it is this:—The proceeding was between Sir James Carnegie and the Montrose Harbour Trustees. Sir James Carnegie had effected certain operations which had not been objected to; then he effected some further operations, which were objected to on the part of the Montrose Harbour Trustees, and they applied to the Court for a suspension and interdict, as we call it, which is similar to an injunction in England, to stop those proceedings. The Court granted the interdict or injunction in the mean time. That is a usual thing upon the first statement of the matter, until there is an opportunity of putting in an answer to the application. Upon the answer being put in, the matter came to be discussed before one of the Judges. Sir James Carnegie, in that answer, maintained several pleas. He maintained, in the first place, that the Montrose Harbour Trustees had no right to object to his proceedings; that their grants did not give them a sufficient title to object to his proceedings. He maintained, further, that his proceedings were in themselves the exercise of a right which belonged to him, and in particular belonged to him, in consequence of tracing the progress of the river in various places, and the alterations it had made,—that he was protecting his own ground and restoring ground that had been partially overflowed by the change of the course of the river; that formerly it had not been overflowed, and that even in its present state it was ground that was, as to a great portion of it, pasture ground, except at Spring tides. He maintained, finally, that the operations he was performing would not be injurious to the harbour of Montrose, and he stated reasons why they would not be injurious. The Judge, on considering the matter, was of opinion that the injunction ought to be recalled. Sir James Carnegie had made an offer of security for payment of any damages that should be found to result from his operations; that is to say, if instead of having a trial by a jury upon speculative evidence as to what would be the result of his operations, they should after experience of them be found practically to produce any evil result, he would be liable for the damage that accrued; and he found security—I believe unlimited security—for seven years, that being held a period sufficient to test the matter practically. The injunction was thereupon removed, but the Bill as it is called was passed to try the question; that is to say, the injunction was removed, but the suit was allowed to exist in order that it might be proceeded with if it should be found necessary to do so. The case was in that position when the papers came to me to consider. There was a report by Mr. Leslie, the engineer, saying that he considered the operations would be injurious to the harbour of Montrose. There had been a previous report by him to Sir James Carnegie, authorizing a part of the operations; but Mr. Leslie thought the remainder of the operations would be injurious to the harbour of Montrose. There was also a report by Mr. Rendel, who concurred in that view. He was at Dundee about some other matters, and there was a communication from the Admiralty to the Trustees of the Montrose Harbour, saying they might avail themselves of Mr. Rendel being there to consult with him. Mr. Blackadder had a different opinion from Mr. Leslie upon the subject, and Mr. George Buchanan had also a different opinion from Mr. Leslie. Mr. George Buchanan is a very eminent engineer, and his opinion upon such matters is considered of great weight. In that state of the matter, the papers were placed before me to consider what was best to be done. It appeared to me, in the first place, that the title of the Admiralty to sue in this matter, was doubtful, there was room for contending that, because there was a grant of the harbour to the Montrose Trustees, the interest in the harbour was thereby transferred; and it appeared to be the duty of the Montrose Harbour Trustees, if there was damage apprehended in the harbour, to defend that right. That raised a question of title, the interest was with them, and it was their province and duty to defend it. I thought Sir James Carnegie's objection to the title of the Montrose Harbour Trustees was not well founded; I thought they had a title to maintain the suit in their own names; but then I saw that the question of title, if persisted in by the Admiralty, would be a very difficult and tedious question, and that we should probably get into the House of Lords before we made any progress in the suit. I further saw that the issue of the question itself on the merits was exceedingly doubtful, that to persist in instituting a speculative inquiry into what would be the injury done to the harbour after the Court had disposed of the matter with the Harbour Trustees, by allowing the operations to proceed upon finding security for the consequences, would be attended with the greatest risk; and that it was not improbable that in such an investigation before a jury, we would be cast. I thought that the prudent course would be to wait for a time, say two or three years, and then see whether the evil apprehended was commencing to operate, and then we might go before a jury with the fact as established, and not with three or four engineers on one side, and three or four on the other side, speculating on

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whether it would be so or would not be so; for although I have every respect for those gentlemen of skill, yet I have seldom seen a case in which there were not as many on the one side as on the other. There would be a feeling of hardship, I think, in the minds of the jury with regard to the breaking down of embankments, which would expose our case to very great risk on a speculative inquiry. If it appears from experience that no practical injury arises, then I do not see any reason why I should advise the Admiralty to step out of their course, in order to have those embankments pulled down; on the contrary, I think they would not succeed with a jury in that case. If there is practical injury, I think they would succeed with a jury; and my view of the case was to let matters alone for a time, not to state our difficulties in any way, or to make them the subject of discussion in the court as to our title. If we found it practically injurious, then the course I had in contemplation was this, that the suit which is raised at the instance of the Montrose Trustees, which is called a suspension, should be revived, and that there would be an action of declarator to have the right fully declared at the instance of the Montrose Harbour Trustees and the Admiralty, and the officers of State, combining these three instances in the form of a declarator; so that if any question was raised as to the rights of the one, it could only be because the right was vested in the other; and in that way I think we should be able to come into court with the existence of a practical evil, which would overcome any feeling of hardship, and enable us to succeed in our suit; I have been of opinion that until we are in a condition to say that there is some practical injury, it would be a hazardous suit to embark in, and an adverse verdict in the speculative inquiry would be found to be a serious obstacle if practical injury should, after a time, be found to result from the operations.

1420. (*Mr. Hume.*) What is your view with regard to the power of the Crown, as you are aware that, by the Act of Charles, the Crown has a right to all lands below high-water mark. Does that power extend to Scotland?—We have a question just now in regard to the encroachments at Portobello, where the matter of the right of the Crown in regard to the shore is under discussion.

1421. Are you aware that, with respect to the Tay, two or three actions have taken place where the parties have been compelled to withdraw all the obstructions to the navigation within all below high water?—There are some cases about embankments on the Forth and the Clyde, which were the subject of discussion. We have the law under discussion in that Portobello case just now.

1422. (Mr. *Godson.*) In what stage is that case?—The discussion has arisen in the form of preparing issues for the jury. The Crown are there complaining of the encroachment, and the question comes to be, what is the extent of the rights of the Crown, in order to settle what issues we are entitled to take in the trial of the cause. That is to prevent encroachment. After damming out the sea, the party claims it to be his property. When a party embanks opposite to his lands, the property of the shore, generally speaking, belongs to him. There were some other cases, and we have all those cases referred to in this question at Portobello.

1423. What is the name of the case?—It is the Officers of State against Mr. Smith.

1424. Have a part of the encroachments been made under the direction of the engineer, Mr. Leslie?—Yes; part of Sir James Carnegie's operations appear to have been so made.

1425. By what authority would he do that?—He did it by no authority, so far as I know; but he being the engineer of the Montrose Harbour Trustees at the time was of opinion that the operation would be no injury, and he would maintain that opinion still.

1426. (Mr. *Hume.*) Was there any Minute of the Commissioners of Montrose Harbour, authorizing him as their officer to do so?—I do not understand that be bound the Montrose Harbour Trustees.

1427. (Mr. *Rice.*) Was Mr. Leslie the engineer of the Montrose Harbour Trustees?—He was at that time. It so appears from the papers.

1428. Are you of opinion that the grant to the Montrose Trustees superseded in any degree the rights of the Admiralty to interfere?—I think there is very considerable doubt upon that. My inclination of opinion is, that the Montrose Harbour Trustees are the proper pursuers of the action, and not the Admiralty.

1429. Are the Commission to understand from your opinion that the grant to the Montrose Trustees does in any degree supersede the right of the Admiralty to interfere in this case?—That is a question of very considerable doubt.

1430. (Mr. *Hume.*) If the Trustees of Montrose Harbour, as to whom there is a doubt whether the power given to them did not supersede the power of the Admiralty, have applied to the Admiralty, pointing out their inability to carry on the suit from want of means, and requested the interference of the Admiralty, would not that be sufficient authority for the Admiralty to proceed?—In that case, if the title was in the Montrose Harbour Trustees, the Admiralty would have to proceed in the name of the Montrose Harbour Trustees. But what I would recommend, if the fact is found to support the opinion of Mr. Rendel, would be that an action of declarator, an additional action, should be raised in the names of all the perties I have mentioned, and conjoined (as we call it) with the action that is already in Court, at the instance of the Montrose Harbour Trustees, so as to bar all difficulty of title, averring that injury has actually occurred, and concluding that the ground of it should be removed. I think that if we raised the simple action at the instance of the Admiralty now, we should be taken to the House of Lords on the title.

1431. (Mr. *Rice.*) It would be like so many counts in an indictment, in fact?—One question there is, who has the real title to sue. Sir James Carnegie pleads just now that the title is not in the Montrose Harbour Trustees. If the action had been brought at the instance of the Admiralty, I have no doubt Sir James Carnegie would have pleaded that it is in the Montrose Harbour Trustees, and not the Admiralty; or perhaps he would have raised a question, whether it is not really in the Crown itself, which is a doubtful matter also. If the officers of State,

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as representing the Crown itself, had brought the action alone, he would probably have said it was in the other parties. What I would recommend, if there is an actual injury proved to exist, is, that an action should be raised in the names of those three parties. Then Sir James Carnegie cannot say it is transferred to the Montrose Harbour Trustees; at least he cannot say it to any effect, because still the answer is, that they are pursuers.

1432. (Mr. *Godson.*) In other words, that is similar to an interpleader here?—Perhaps it is; I am merely stating what I would recommend as the most likely mode of obtaining a verdict in this case.

1433. (Mr. *Hume.*) How long is it your intention to wait?—What I would say on that point is, that some engineer, who can be relied on, should go to look at the place, probably in the course of the autumn of the present year, to say whether he sees any practical injury arising, or, if not, in the course of the next spring. The security lasts seven years.

1434. Suppose the Commission already have reports from capable engineers of the injury done?—I am not talking of an opinion that injury may or will occur. Some engineers say that injury will occur, that there will be a certain degree of want of scouring of the harbour and silting up. Other engineers say that will not be the result. If they say, We have now examined it again, and there is a certain degree of injury already actually resulting, then I would say, commence your action, and come upon Sir James Carnegie for damages.

1435. (*Capt. Sir G. Bremer.*) What is the state of the embankments?—They are quite finished; they were finished before we took up the matter at all.

1436. (Mr. *Godson.*) Are the Commission to understand that the acts of Mr. Leslie have not in any way compromised the Admiralty?—I am of opinion, that in law, they have not; I have no doubt about that.

1437. In the case of the Queen against Smith, within what time is the judgment likely to be obtained, so as to state what is the real law with respect to pulling down embankments or encroachments?—I should think it will be disposed of in the course of this summer session.

1438. Is there any fact that will at all impede the judges in giving an opinion upon the law?—No, I think not.

1439. (Mr. *Hume.*) The question is, who is the proprietor of the property so embanked, is it not?—No; the question is, whether Mr. Smith is entitled to encroach on the shore of Portobello, or whether the Crown is entitled to prevent him: he has built a wall, and he was allowed to complete the wall under a notice that that should not interfere in any way with the right of challenge; he had got it up about 4 or 5 feet, and he was allowed to add another foot to it.

1440. (Mr. *Godson.*) In that case must an opinion be given, aye or no, what is the power?—Yes, what is the extent of the Crown's right of interference.

1441. (*Chairman.*) Will you be so good as to state to the Commission generally any legal decisions that your Lordship may happen to remember relative to embankments of land or encroachments upon rivers or harbours, as on the Clyde, Tay, or elsewhere?—Some questions arose in regard to the powers of the River Clyde Trustees who had made embankments for the navigation of the river, to narrow the stream and eddy, deepening the channel in that way. The land gained on each side accrued to the proprietors by a reserving clause in the Clyde Navigation Act. The Navigation Trustees were advised that embanking the river and making it so narrow was not an expedient thing for the navigation, and they proposed to demolish part of that embankment. Some of the proprietors resisted, and said, "This land is ours, and you must not touch it; or, at least, you must give us compensation." In that case the Navigation Trustees contended, and successfully, to my recollection, before Lord Jeffrey, that the primary object was the navigation of the river, and that though they tried this experiment of embanking they were equally entitled to try how it would do without embanking, and that, in point of fact, there was nothing to prevent them, if they found the experiment unsuccessful, from restoring the alveus of the river. The Court, and afterwards the House of Lords, gave effect to the views of the trustees.

1442. (Mr. *Hume.*) Is it not the case that by a decision, payment for certain alveus, or ground recovered from the river, was stopped to those alleged proprietors who claimed it, and that it is now reserved and held for the Government?—That is a different case; that is a question which turns entirely upon the interpretation of certain clauses in the statute. It is a question whether the Crown is entitled to a certain portion of the damages that are to be recovered for certain property on the banks of the Clyde.

1443. Is it not the shore of the land?—It is the shore of the land that formerly was the bed of the river; but the question turns on the clause of the Act of Parliament, which provide specially for that case in the Clyde Navigation Act; it does not rest on general law; it turns on the provisions of the Act.

1444. Do you think that the private Act of the trustees superseded the general law of the land?—There was a special provision as to the disposal of the money that was to be got from that subject. It was specially disposed of by the Act of Parliament.

1445. Do you think that precludes the power of the Crown to assert any claim to that property?—The assent of the Crown I understood was given to the Act; and when the Act does dispose of the money, we must deal with it according as the Act disposes of it; and the question arises whether, under the terms of the Act, a certain portion of it does not belong to the trustees.

1446. (Mr. *Godson.*) Having stated that the Crown has a right to pull down these embankments, is there any law in Scotland as to the time, so as to limit the Crown at all in point of time for pulling them down?—It is still a moot point how far prescription runs against the Crown; whether the Crown can suffer by the negligence of its officers.

1447. Assuming for a moment that it could suffer, is any time limited within which it should occur?—Forty years.

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1448. (*Capt. Washington.*) According to the decision in the case you have just mentioned, would not the Clyde Trustees have power to pull down any part of the embankments which they thought necessary for the benefit of the navigation within the limits of the river up to high water mark?—I think they would.

1449. Will your lordship be good enough to name the cases you refer to?—One case which I have already referred to was that of Todd against The Clyde Trustees, affirmed in the House of Lords in 1841, reported in the 2nd vol. of Robinson's Appeal Cases. I may refer the Committee to the following cases:—Smart *v.* Magistrates of Dundee, 1797, 8 Brown's Cases of Parliament; Magistrates of Culross *v.* Geddes, 1809; Leven *v.* Magistrates of Burntisland, 1812; Campbell *v.* Brown, 1813; Boucher *v.* Crawfurd, 1814; Berry *v.* Holden, 1840.

1450. (Mr. *Hume.*) Will your lordship be good enough to define what is meant by the term "alveus," which has been repeatedly used before this Commission?—It is a term frequently used to denote the bed or channel of a river.

[*The Witness withdrew.*]

Capt. Henry Mangles Denham, R.N., and F.R.S., further examined.

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[*Capt. Denham's Plans of Morecambe Bay and of the Duddon Estuary were laid on the table.*]

1451. (*Chairman.*) In your examination of the north-west coast of England did you survey the Duddon water?—Yes.

1452. You are aware of the line on which the Whitehaven and Furness Junction Railroad proposes to cross that water by a solid embankment?—I am aware of the line; but I was not aware that it was to be a solid embankment.

1453. State to the Commission your opinion as to whether, with due regard to the present and prospective interests of navigation, a solid embankment is desirable, and what in your opinion would be its effect upon the navigation?—It would cut off certain vessels which now go up to the Broughton quarries, and such vessels as carry coal, manure, and limestone up and down, which is very trifling; and as the estuary presents no refuge capacity, I consider that an embankment right across, if crossed at all, would be more beneficial solid than open.

1454. What depth of water is there in the proposed line?—Twenty feet in the channel at high water ordinary spring tides.

1455. How far is that below the point of navigation?—Three miles below the Broughton quarry shipping place.

1456. (Mr. *Godson.*) What is the name of the Broughton quarry shipping place?—The Burlington Slate Quarries.

1457. (*Chairman.*) How much further up to Broughton?—Four and a half miles below where vessels drawing six feet can reach at high water spring tide.

1458. (Mr. *Hume.*) Do any wherries or flat-bottom boats go higher up than 4½ miles?—Open punts up to Duddon Bridge.

1459. Is there any flow of the tide above Duddon Bridge?—There is when great tides occur, but rarely, above ½ a mile.

1460. (*Capt. Beaufort.*) What is the rate of the flow of the tide up and down at the proposed place of embankment?—Three knots on the flood and 3½ on the ebb.

1461. Would not that be entirely put a stop to by the embankment?—It would.

1462. Consequently, would not the parts of the country above that embankment be deprived of the benefit of water-carriage?—To those places to which I have alluded.

1463. Would not the whole surrounding country be equally deprived of it?—From the trade I am at all aware of, I imagine it would be a very slight privation to the country in general.

1464. Will you state what extent of country round the estuary is supplied, or can be supplied, either for landing or shipping?—It is difficult to estimate that.

1465. Is not this estuary the outlet for the waters from the Duddon and Kirby Pool?—Yes; but neither of those waters bear down any traffic that I am aware of.

1466. (*Capt. Washington.*) Are there not large slate-quarries belonging to the Earl of Burlington on the banks of Kirby Pool?—There are, but so useless is the estuary considered to them that his Lordship has determined to form a railroad independent of the estuary, to get rid of the constant demurrage which the detention of tide has occasioned, and that railroad is to come down to Piel Harbour.

1467. (Mr. *Godson.*) There is one already down to Piel Harbour now being made, is there not?—Yes.

1468. Is the railroad now proposed to come into that small line of six miles long?—Yes.

1469. Supposing an embankment to be made where it is proposed to make one, how many square miles of country is the estuary the means of draining?—Duddon Bridge at once provides for all the water that comes down from the lakes. Kirby Pool has its own sluice-gate and bridge. Simpson's Beck and Salt-house Pool have each a bridge and sluice-gate that provide for all the outlet, and to exclude any tidal-water that it is desirable to exclude in high tides.

1470. After the tide is gone down, does it not all come down the channel, across which it is the intention to put the embankment?—Decidedly, and there forms a main trunk.

1471. Having taken away all that flow of water above the embankment, in what way would you keep the channel open below the embankment?—I consider when an embankment is driven across the designed part that no channel would be desirable for navigable purposes.

1472. Then are the Commission to understand that, in your opinion, the placing of the

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embankment will destroy the whole of the Duddon Estuary as to navigable purposes?—It wholly destroys it.

1473. (Mr. *Hume.*) Can you estimate the quantity of water at high spring-tide that covers that estuary above where the embankment is proposed?—Assuming the area at 5000 acres, and the average depth at a mean of spring and neap tides at 6 feet, it would exclude about 1300 millions cubic feet of water on every tide.

1474. (Mr. *Godson.*) It having been stated to the Commission that it is to be a solid embankment, to be made by means of stones driven down gradually and the sand silted up, will you state in what way the waters above that embankment are to be disposed of?—They could not be disposed of at all if the embankment was without sluice-gates.

1475. Would it not require therefore some new channel to be cut through another part of the land to get into the lower part?—That would be one way of disposing of the waters.

1476. Would that assist or not assist keeping the part below and towards the sea in a navigable state?—I think it would not, inasmuch as the river now, with all the outfall of the tidal-water, does not preserve a channel at all that is navigable at low water; so do I not think that the river merely passing down with all the backwater cut off would be more than making its escape through gutter-ways that would never be navigable.

1477. Are the Commission to understand that the cutting a passage through the land, so as to dispose of the water above the embankment, by introducing it again into the estuary below the embankment, would or would not affect the navigation of the part below the embankment?—Not to any navigable purposes.

1478. It would not assist it?—It would not; it would be futile.

1479. (*Chairman*) From your knowledge of the country, can you point out any eligible line of road by which public accommodation may be secured, and at the same time the rights of navigation preserved?—Yes; I conceive that that railway may be carried for the purposes intended, by going up one side of the estuary and down the other.

1480. How much further round would it be by going up one side of the estuary and down the other?—Eight miles in circuit.

1481. In your opinion, by following the course you would recommend, you do not interfere with the navigation of the waters at all?—A few stone or coal flats could go at spring tides above that.

1482. (Mr. *Hume.*) What kind of a bridge or passage do you propose for that three-quarters of a mile without injury to the navigation?—I would not recommend anything like a swing bridge, or any bridge that could pass vessels, in the railway across. A bridge that would be proper to let the river freshes out could not be a bridge that would allow vessels to pass up at any time.

1483. (Mr. *Rice.*) It could only be an embankment with arches?—Yes.

1484. In your former evidence you produced some plans with regard to a supposed crossing of Morecambe Bay?—Yes.

1485. Would you recommend a similar construction in the event of the railway being constructed?—Yes.

1486. (Mr. *Godson.*) Have you ascertained how deep the sand is, so as to know whether rubble stones would make a foundation?—Yes.

1487. About what depth is the sand?—From 9 to 10 feet.

1488. Would you not require to have something put down at the bottom of those 9 or 10 feet before the rubble stones would take any hold, by which they could be kept in their place?—Piles would be driven into the clay or marl.

1489. Then between those piles you drop the stones, do you not?—Yes, until we come above the sand.

1490. Then you would trust to the tide bringing more sand, as you gradually drop other stones down?—Yes.

1491. And thus you would rise higher and higher?—Yes, until the tide was shut out.

1492. (Mr. *Hume.*) What was the nature of the plan for Morecambe Bay; did you leave any water way, and how much across the sand?—I did not then speak of leaving a water way, but I stated the amount of waters that would have to be provided for, showing the bridges and culverts that now provide for it.

1493. Do you propose to provide for the same waters in that embankment, in case it should cross Morecambe Bay?—Yes.

1494. (Mr. *Godson.*) By the words "providing for the waters," do you mean they would go down their own channel, or have new channels for them?—In enclosing the interior part, the rivers would not be left to take their own course, but would be embanked laterally by dykes, and conducted down to the proper orifice in the embankment.

1495. (Mr. *Hume*) Do you contemplate the shutting out the flow of the tide above that embankment?—Quite so.

1496. Do you, in the embankment at that place, contemplate also shutting out the tide there?—Certainly, without which it would be no boon to the public. I consider the water traffic so unimportant that if the embankment was carried across it would be better solid than open.

1497. (Mr. *Rice.*) Are you aware of the proposed cut alluded to by Mr. Stephenson?—Yes.

1498. (*Capt. Beaufort.*) You stated that the Duddon never can be turned to any useful purpose for a refuge for ships in distress?—Yes.

1499. Might not a judicious system of dredging so as to straighten some of those channels, placing buoys and beacons, contrive to leave an open channel through which ships could go in distress?—I think not.

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1500. Could nothing he done by the skill of the engineer?—I think not. The bar extends so far outside the line of coast right and left, that I consider it would he perfectly hopeless.

1501. How many miles is the five-fathom line from the north point of entrance of the Duddon?—Two nautic miles.

1502. At such a distance, you think nothing could be done to save a ship in crossing a two-mile bank?—Nothing more than now exists when the tide lifts; for instance, there are several tracks where there would he 20 feet, that would enable vessels to cross those banks.

1503. The question was, whether a judicious system of engineering would not keep the channel open out to that five-fathom edge?—I think not.

1504. (Mr. *Hume.*) There appears to be an embankment from Salt House Pool. Can you state what it was for?—It was embanked by the late Lord Lonsdale in 1830 for the redemption of 260 acres of land over which the sea ranged.

1505. Are you aware what depth of water flowed over those lands?—I should think at high-water spring about 2 feet.

1506. What quantity of water would that exclude?—Seven and a half million cubic feet.

1507. Were there any other banks in that estuary to exclude the tidal waters?—Yes; there are several running down on each side.

1508. The object of which was to exclude the water and reclaim the land, was it not?—Yes.

1509. (*Capt. Beaufort.*) Can you state whether you think it probable that a railway could be made without great engineering expense to the north of Millom hill?—Not very well to the north, but immediately to the southward.

1510. (Mr. *Godson.*) Supposing a railway to be taken from Poulton on the Lancaster side of Morecambe Bay to Cowper Point on the promontory of Cartmell to Chapel Island, and from Chapel Island to the mainland on the north-eastern side of Morecambe Bay so as to join the Whitehaven and Furness Railway across the Duddon Sands, in your opinion, what would he the injury to the navigation of Morecambe Bay?—It would he shutting up the Ulverstone Canal foot, which admits vessels drawing 13 feet water at high tide spring. It would shut up the intercourse with the river Severn, which is navigable up to the gun-powder-works of Blind Bridge, a distance of 3 miles and a half, also to the Quay's Green Odd, to where vessels of 10 feet draught of water arrive, also 3 miles above on the Ulverstone side. It would shut out all intercourse with the grange district 4 miles above the embankment, such coasters as now trade with Milnthorpe 8 miles above. So far I have alluded to existing coasting trade. It would then interdict for ever the formation of the new harbour, which I see so practicable for the restoration of the trade of Lancaster at Poulton Ring. It would also shut out a hundred or so of boats which carry on shrimp-taking and other fishing.

1511. Name a few of the rivers, the scouring of which assists the navigation that would then be shut out, and the quantity of water?—The Leven, Rusland Pool, the Crake, the Crakheik, the Kent, the Gilpin, the Beetha, the Whinster, the Ulpha Pool, and the Keer.

1512. (Mr. *Hume.*) State to the Commission your opinion whether, with a due regard to the present and the prospective interests of the navigation, such an embankment is desirable?—I should say that, with the exception of the projected new port at Lancaster, the advantage would be in favour of the public by the embankment.

1513. Would not the shutting out so large a quantity of water as that which you have now stated to come tend very much to allow the channel to silt up?—I think it would silt up the different channels that now stand between the spits of the banks.

1514. Would not that he injurious to the navigation?—Not to the navigation of the three early tide ports, that now stand below that line.

1515. Which are they?—The Lune, the Wyre, and Piel Harbour. To all above it would destroy it, as well as the projected new port at Poulton.

1516. (*Capt. Beaufort.*) Deposition would go on still from those three rivers that are left open?—Not as it does now. To entrap the silt that now comes down would he a work of artificial effort; it would render them purer as they came out into the bay.

1517. After that was effected they would not go on depositing outside?—I think there would not he that dipping down which now keeps the Lune Deep open and so deep as it is, but as it is so unnecessarily deep, it would he ages before it would silt up so as to he of any consequence to navigation.

1518. (Mr. *Hume.*) In your survey around the Duddon waters and Morecambe Bay, did you observe embankments on either side, being encroachments, to keep out the tidal waters?—Yes.

1519. Are there many?—Not so many after you get to the southward of the Duddon, after you get into Lancashire.

1520. But in the Duddon there is the one now stated of 260 acres, and there are several others above, that you have mentioned?—Yes.

1521. Did you examine the extent of any of the other embankments?—Their actual sea face I did, but not the quantity of ground that they take in. That is being fully developed by the Ordnance survey.

1522. Did they in your view exclude any large portion of water from the respective places?—Yes, but not such water as one would covet for the sake of scour.

1523. Do not all waters that flow up tend to scour in their return?—It depends on the marginal nature I may say of the estuary. Tidal water would come in clear and go off as thick as mud from the frittering away of the shores as it comes in, and that water goes out inimically to the bars of the estuary, instead of cleaning it in proportion to the scour.

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1524. Then what water is it in your opinion that does assist the scour of bars?—All the water that comes in, however thick, will assist in keeping open a channel, if it is only a gutter-way; but in proportion as that is kept open, so the bar progresses seaward, and the shelves extend off shore.

1525. Carrying it into deeper water, and consequently rendering the harbour more accessible?—Rendering it by degrees like Liverpool more inaccessible, as time goes on, and from the manner the soundings are carried out, we see exactly where all the shelves are rising.

1526. Having seen them, are you able to state in what way any measures as preventives can be now taken to guard against the result you look to?—I think that where the bar has extended to what I term the vanishing point of the velocity of the ebb tide, that is supposing the ebb tide went eight or 10 miles down, there when once the accumulation begins to take place it will go on aggravating itself, and then it is hopeless, it will always be there accumulating; but wherever the bar lies within the range of the whole transit of the ebb tide there is a chance of artificial effort being successful.

1527. Must not the accumulation of that bank depend on the depth of the water to which the ebb tide would carry the silt and mud?—Not so much as to the depth as to the cross of fair channel stream. Take the Wyre as an instance of a little estuary emptying itself; it has come down from time immemorial; that bar is at the same distance that it was, two miles. I attribute that entirely to all the sediment of the Wyre coming down, being cut off at right angles by a more powerful stream, called the Lune Stream. If I take the Duddon, I find that it is projecting, consequently adding, and it will go on adding till it gets into the fair set of the Irish Sea ebb and flood, clear of the points of the adjacent lands. The bar will project, and always try to get up to low water level at neap tide, and though it may tumble into 40 feet water directly, yet it will then be a steep-to sort of shelf, instead of having worn to a gradual shoal, it presents to my mind a much more dangerous bar than before, when lying within the range of coast.

1528. (*Mr. Rice.*) In answer to a former question put to you by Captain Beaufort, did you mean to say it was impossible for an engineer to make a channel, or that you thought, looking to the comparative advantage of the expense, it would not be desirable?—I look really to the total impossibility; that is, if you had all the dredging or excavation means to work during one tide, that the next tide would fill it up, or nearly so, and there would be no permanency whatever in it. When I perceive any estuary representing a prostrate cone, with its base outwards, I give it up as likely to produce any permanent channel through its sands.

1529. (*Capt. Beaufort.*) Is not that the character of all estuaries?—No; we have before us a case in point, the Dee and the Mersey. The Mersey may be represented as a bottle, with its neck outward, and the impetus of the backwater through the straits of three or four miles, with very high banks seaward, called the Burbo Banks, allows a channel of four miles to be kept down towards the northern horn of the bay, called Formby, and there it breaks off seaward; but in proportion as it expands a deposit takes place, and is still taking place. But the difference for navigable purposes between the Mersey and Dee is, that the Dee does not conduct any force, but loses it from the first moment of emptying itself. It extends as far as it can into the Irish Sea, where the Irish Sea stream cuts off westward laterally to the shore towards Holyhead, and the line of that sea twisting and closing as it goes; so that, in fact, the bar of the Dee is as much leeward of its orifice as it is directly seaward of it.

1530. (*Mr. Hume.*) Do you mean that the sand and material carried down by the stream of the Dee is swept by the stronger current of the Irish ocean towards Holyhead, in that direction?—Yes, with also the emptying of the Mersey, which is above it on the ebb.

1531. Do you consider that that bank at the mouth of the Mersey is forming where there is an eddy between the stream from the Mersey and the stream from the Channel?—Yes.

1532. And that wherever an eddy of that kind exists on the coast by streams meeting, there is a danger of the formation of these banks?—Yes; but in such a case as the bank that extends between the promontory which divides the Mersey from the Dee, it is owing to the bank that extends outward from that promontory that we have any channel at all on either side, that is, for the rivers themselves. If the Burbo and the East Hoyle Bank did not exist, the water of the Mersey would turn short round and spread itself over the mouth of the Dee.

1533. (*Mr. Rice.*) You mean to say that the effect on the outer current of the sea is to carry part of the deposit that comes from the Mersey, and to deposit it at the mouth of the Dee?—Yes; going back to the first conception that the mouth of the Dee presents a prostrate cone and loses its power from the moment, it begins to ebb instead of obtaining an increased power, as the emptying of the Mersey estuary does.

1534. (*Mr. Hume.*) What are the best means you can suggest to the Board for keeping open rivers and estuaries, such as you have stated?—To take a case more completely before the Commission, I will take the Sunderland shoulder that projects from the Lune as a tongue formed by the exit of the Lune on the one side and the outfall of the Morecambe Bay waters on the other; and answering the question, I would say, that the only chance of improving the Lune navigation down its sea reach of sand would be, if possible, (which I believe to be an engineering possibility,) to embank that tongue on its river and sea face.

1535. Do you mean by that to narrow the ebb so as to throw it on a particular channel, giving it more force by contracting its ebb?—A most essential advantage would arise from the cross set of the bay tide not setting across that channel.

1536. If the embankment was so formed, would not the exuvia and silt be carried further out and prolong that tongue which is now an objection?—Yes; it would go on feeding in this case till it got into the Lune Deep, and there it would be arrested, and for a time having so much more depth to feed up the other, it could only be arrested in its advance by the strong tide coming across it.

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1537. (Mr. *Godson.*) Would any embankment across the Morecambe Bay at the place proposed have any effect on the sea-reach sand at the mouth of the Lune?—I consider that it would have a beneficial effect.

1538. In what way would it have a beneficial effect on the sea-reach sands at the mouth of the Lune?—The Sunderland Shoulder is so fed by the scour of the upper banks and soil of Morecambe Bay by the powerful outfall which now exists, that anything that would diminish that powerful outfall would tend to bring less down upon Sunderland Shoulder and Cockerham Bank which now form the sea-reach, giving the scour of the Lune itself more effect than it now can maintain.

1539. Would not the effect of an embankment across the bay be to alter the direction in which the tide will come in and out?—The tendency of the tide would be altered; but I conceive an advantage would arise from that alteration.

1540. As a matter of science, can you predict the way in which the tide would go after you have made an embankment of 12 miles across the bay?—Certainly: we have then decided elements to guide us.

1541. (*Captain Beaufort.*) Would not the method you propose to pursue with respect to the river Lune, in walling the sides and conducting the stream down, apply to the rivers Kent and Leven in bringing two channels down completely into the offing?—If I may point out the Cartmell wharfs as resulting from the same directing influence of ebb-tides as the Sunderland Shoulder is produced by the promontory of Heysham, I should then say that if Cartmell Wharf be walled up as far as it now dries out to low-water neaps, a more permanent direction and deeper capacity would be given to the Leven on the northern side and the Kent and other rivers which pour into the Kent on the southern.

1542. It would have the effect by deepening?—It would.

1543. What is the cause of the Lune Deep?—Looking at the Lune Deep lying between the two extremes of the arm of Morecambe Bay, Walney Point and Rossall Point, eight miles across, Lune Deep, lies one-fourth nearer to the Rossall side, I conceive that the submarine matter on either side of the Lune Deep is that of original formation and not of deposit. I, therefore consider Lune Deep as the original outlet of the Lune waters and Morecambe Bay rivers at a time when three-fourths of the now under-water surface to the northward was solid *terra firma*, and hence the cause of Lune Deep.

1544. What prevents the sand filling up Lune Deep as well as the adjacent parts, which, according to your statement, it has filled up?—It has filled up no place by deposit right or left, but it has filled up vastly in the interior part. There having been an original dyke, the rush of flood-tide into that bay, as fast as the bay became scooped out on its margins, and which is daily going on, it is scooped by the tide either way; the tide dips down to the last, with all the outfall of Morecambe Bay; looking at the channel right and left, and at the body of flood-tide necessary to fill that bay, the pressure back is quite an equivalent to what is brought down at the head of it, so as to avert its filling up rapidly.

1545. As soon as Morecambe Bay should be cut off by an embankment, the water let in, and the outfall from that again when that has ceased, and the course of the tide consequently altered, would not then the sand break in immediately and Lune Deep be filled up?—Yes; but very slowly.

[*The Witness withdrew.*]

The *Earl of Lonsdale,* Chairman of the Whitehaven and Furness Railway, examined.

The Earl of Lonsdale.

1546. (Mr. *Hume.*) Is your lordship proprietor of any portion of land on either side of Duddon estuary?—About 1000 acres.

1547. On the maps there is an embankment, stated to have been made by the late Earl of Lonsdale, a few years ago, to the extent of between 200 and 300 acres; under what authority was that enclosed?—Under the Millom Enclosure Act.

1548. In what year did that pass?—On the 22d of June, 1820.

1549. What is the object of that Act; is it to enclose more land?—Yes.

1550. Will you state what extent of land under that Act you could enclose?—About 1000 acres.

1551. In what direction from that embankment?—Up to what is called the mid stream.

1552. Was that Bill passed solely to enclose that part or any other part of the estuary?—It was a Bill to enclose all the wastes in the parish of Millom, and that allotment was given to my family.

1553. Was there any opposition to that embankment?—None at all.

1554. Do you know whether the opinion of the Admiralty of the day was given, as to whether that would injure or interfere with the navigation?—I should think not.

1555. Do you as proprietor consider that you have a right to the land under the high-water mark, if you can enclose it?—Yes; but it is nearly all low water; all that land is dry at low water.

1556. Is it always covered during flood?—Yes.

1557. (Mr. *Rice.*) Is there any boundary to the enclosure?—There is the Commissioners' award.

1558. You mention mid channel, is that the boundary?—Yes.

1559. (Mr. *Hume.*) Do you know whether there is any Bill that has passed for enclosing any other portion of the Duddon estuary?—I am not aware of it.

1560. If an embankment was formed across Duddon, at the place stated by Mr. Stephenson, is there any intention to carry on that line further across any portion of Morecambe Bay?—

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This Bill is to cross the Duddon sand. There is a projected railroad, which is not now before Parliament, to cross higher up, but it takes a very small portion of the sand, as compared with the former project of crossing the Duddon.

1561. There is no Bill for that introduced as yet?—No.

1562. The Bill for which you appear is the one for crossing the Duddon Sand, as stated by Mr. Stephenson?—Yes.

[*The Witness withdrew.*]

Mr. *J. Leslie.*

Mr. *James Leslie,* of Dundee, M. Inst. Civil Engineers, further examined.

1563. (Mr. *Hume.*) Have you acted as engineer to the Commissioners of Montrose Harbour?—Yes.

1564. Since what year?—The Harbour Bill passed in 1837, and I acted as their engineer until about 1843, when the new dock they have constructed was finished; I am so still, but they have no work doing just now.

1565. During the time you have been their engineer have you been consulted, or given any opinion to Sir James Carnegie, respecting the enclosure of land in the basin of Montrose?—Not regarding the enclosure of land; I was consulted by Sir James Carnegie in 1841 about the best mode of protecting his land from being encroached upon by the River South Esk, and I recommended that he should divert the channel of the river a little, which he did.

1566. Will you explain what was your object in the report that you made to Sir James Carnegie?—The river was cutting the land very much on the south side, and he stated that he had been advised by Mr. Blackadder, civil engineer, to turn the channel of the river into what had been its course formerly, and I agreed with Mr. Blackadder that that was the best thing Sir James Carnegie could do, and advised him accordingly. The letter to me was asking me to come and advise him about the protection of his land on the South Esk. When I met him at the place appointed, he hinted at his wish to embank land, and I told him I thought he had better not attempt it, because the trustees of Montrose Harbour would decidedly object to it, as they had been cautioned by Mr. Walker, civil engineer, to watch and resist any encroachments on the basin, which he called the "lungs of the harbour." Sir James built an embankment on the side of the river, so as to change the channel that year, and then next year, without saying anything to anybody, he ran an embankment across the whole lower end of it, and shut out the water.

1567. Would that embankment which you recommended have prevented the South Esk from cutting his land, but at the same time have allowed the flow of the tide upwards?—The flow of the tide would have been just the same as before; it merely changed the channel of the river.

1568. And would have prevented any portion of his land being cut off by the flood of the Esk?—Yes.

1569. There would have been no interruption to the flow of the tide?—None.

1570. Did you in giving that advice give him the advice as engineer to the Montrose Harbour, or independent of that?—Quite independent of that; I had no idea there was to be anything affecting Montrose Harbour.

1571. Did you report to the Commissioners that you had given that advice?—At that time I do not think I did, because it seemed to me not to be a matter affecting the harbour of Montrose.

1572. Are you aware whether the Commissioners gave any sanction to Sir James Carnegie to make that embankment along the river?—No previous sanction; but they went up one time to see what he was doing, after the work had been commenced, and having examined the embankment and heard the statement and explanations of Mr. Lyall, the factor, they returned perfectly satisfied that what he was doing was no harm to Montrose Harbour.

1573. That was the first year he defended himself from the South Esk?—Yes.

1574. Afterwards, when he enclosed the ground and shut out the tide, do you know whether the Commissioners of Montrose took any notice of it?—Not until the work was far advanced and the water excluded, because they did not know sooner. One day, when I was at Montrose, I heard of it accidentally and told them of it, and when they heard of it they objected.

1575. They never, as far as you know, gave their sanction to any enclosure that would shut out the tide?—Certainly not.

1576. What area has been enclosed?—About 62½ acres on the east, and 3½ on the west side of the new river channel.

2577. What authority have you for believing that the ancient stream of the river was to the north of that line that formerly existed?—I think I saw it marked on some old plan.

5578. But although the stream was there, yet the tide flowed over the land south of that stream?—Certainly.

5579. Then the basin has been reduced in size by that enclosure of 66 acres?—Yes.

5580. Are you aware what depth of water used to flow over that?—About 4 feet on an average at spring tides.

1581. (*Capt. Washington.*) Taking the area at 66 acres, and the mean depth at high water at 4 feet, would not that exclude about 4,000,000 cubic feet of water on every tide?—Fully 4,000,000 at neaps, and 12,000,000 at springs.

1581* Are you acquainted with the embankment marked in the map 1831?—Yes.

1582. Is it not on Sir James Carnegie's property?—Yes.

1583. Then it appears that the embankment of 1842 of 66 acres is the second embankment of nearly similar extent, or is in addition to that made in 1831?—Yes.

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1584. Are you aware whether that was ever covered by the water?—I know it was covered with the water; I know it by the levels.

1585. To what extent is the level of the land there below the ordinary level?—I suppose it is much about the same level as the part more recently enclosed.

1586. What is the level below high water of the embankment of 1842?—At ordinary spring tides I suppose it is about 4 feet of water.

1587. Then assuming that space embanked, as it appears by the map now on the table, to be 50 acres in extent, has not the embankment of 1831 excluded about 3,000,000 cubic feet of water in every tide in addition to the four millions excluded by that of 1842?—I conceive so; and that in spring tides it would exclude 9,000,000 cubic feet of water.

1588. (Mr. *Hume.*) In bringing the recent embankment to the notice of the Commissioners of Montrose Harbour, did you do so under a belief or an opinion that that enclosure would injure the navigation of the harbour?—Yes.

1589. Is it your opinion that shutting out the tidal water by enclosures of that nature tends to lessen the ebb, and consequently encourage the deposition of silt?—Decidedly so.

1590. What other rivers have you been employed on as an engineer?—I am engineer to the Dundee Harbour Trustees.

1591. Have you attended to the encroachments that have been made on the Tay River?—Yes.

1592. Will you state what encroachments have come more immediately under your notice?—The encroachment that has come more immediately under my notice is this: there is a long wall built for Lord Kinnaird projecting at right angles from the north shore of the Tay.

1593. In what part?—Near Powgavie, about six miles above Dundee.

1594. Did you, as engineer to the Dundee Harbour Commissioners, point that out to them as a work likely to be injurious to the harbour?—I did.

1595. In what year did you make the report?—That was about 18 months ago.

1596. Have any proceedings been taken by the Commissioners to remove that wall?—No legal proceedings have been taken. I thought it better they should have a higher authority, and I advised them to get some other person to look at it, and they employed Mr. James Walker, civil engineer; he went there, and reported that the wall was injurious, and that it ought to be pulled down. The trustees have taken no legal steps, but they have given notice to Lord Kinnaird that if he does not remove the wall they will take legal measures.

1597. What length of wall is that to which you allude?—About 3100 feet long.

1598. What would be the effect of that wall if allowed to continue?—It causes a silting up on the north shore.

1599. On both sides of the wall?—Yes.

1600. To what extent, if allowed to continue, would it silt up?—It is difficult to say how much, but if all the walls that are now building on that side of the Tay were completed, and if all the land was silted up within the points of those walls, it would form an area of three square miles, or about one-ninth of the area of the Tay between Dundee and the mouth of the Earn.

1601. Are there other walls built up?—A great many.

1602. By whom?—Mr. Allen, of Errol; Mr. Hunter, of Seaside, and others.

1603. Do you consider these to be encroachments on the navigation?—They are encroachments. The same notice, I think, was sent to the whole of the parties who had been encroaching.

1604. Are the Commission to understand that the encroachments already commenced will, if completed, comprise nearly 2000 acres?—Yes.

1605. In your duty, as engineer, have you pointed out any other impediment to the navigation of the Tay?—Yes; I proposed two years ago to build a wall above the harbour, and to cut away a projecting point of rock at a place called Magdalen Yard.

1606. Is that with a view of setting the current past the sea face of the docks at Dundee?—Yes.

1607. You are aware of a bank called the Middle Bank, extending on the south side, opposite Dundee, a considerable way down the middle of the Tay?—Yes.

1608. Have you been able to form an opinion as to the cause of that bank, and whether it is increasing or decreasing?—I do not know that it is increasing or decreasing. There are banks all the way up the Tay above that, but there are none below it; and the reason there are none below it is because the Tay is contracted after that.

1609. Do you mean that the current below that is so strong that none is allowed to form?—Yes; the channel is narrow compared with the great space to be filled above, and no banks form there.

1610. Are there any points on the south side that set the current off from that, and thus leave a bank to be formed in the eddy?—There is a long bank on the south side further up, called Balmerino Bank.

1611. Can that have the effect of causing an eddy on the spot where the large bank is formed?—I cannot say; the ebb tide sets very strongly against the south shore, opposite Dundee.

1612. Have the Commissioners of the harbour been anxious to deepen the water to the extent of their limits; how far do the Commissioners go up?—The power to execute works only goes as far as the harbour itself, but their boundary as a harbour for collecting dues goes nearly four miles above, to Invergowrie.

1613. Have they done any works up to that extent with a view to deepen the river?—They have not deepened the river; they have removed some rocks opposite the harbour; we tried one year to dredge away the ballast bank.

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1614. Did you succeed?—No; for want of another operation being done above—cutting away the point of rock; it did not succeed; it filled up again.

1615. Are you acquainted with the operation carried on in the upper part of the river by Messrs. Stevenson?—Yes.

1616. What has been the effect of those operations on the navigation?—They have got a considerable additional depth, I believe, in the upper part of the Tay.

1617. Has that been caused by removing the fords and projecting parts in the river and fishing cairns?—Yes; by removing large stones, and dredging and straightening the channel, and removing sinuosities.

1618. Is it your deliberate opinion that that is the best mode of improving the navigation?—For the upper part I think that is decidedly the best plan, but it will not do to persevere with it all the way down to the ocean.

1619. Why not?—Because you would have a bar at the mouth of the river where you come to join the ocean. In my opinion you must have a large estuary within to make the scour over this bar, or otherwise it would get shallow.

1620. Have you not in the Tay a very large estuary for that scour?—Yes.

1621. Will not that scour be increased by every means that increases the volume of the flood?—Certainly.

1622. Then you are of opinion that the measures taken by the Perth navigation are judicious, and likely to benefit navigation below as well as above?—I do not know that it will benefit the navigation below; I do not think it will affect the navigation below at all.

1623. Will it not admit a large portion of water?—It is very trifling; but in principle, of course, it would.

1624. What is the principle that you allude to, which you would recommend to be observed in tidal rivers and harbours?—I think when you have an estuary you should endeavour if possible to preserve it entire, and not allow it to be diminished, so that you may keep the great scour over the bar at the mouth of it, if possible.

1625. Then any interruption to the flood must lessen the scour, and, consequently, do injury?—Undoubtedly.

1626. (*Capt. Beaufort.*) For what number of years do you know that the point of the Middle Bank has not come lower down the river?—I have known it since 1832, and I do not think it has moved since 1832.

1627. (Mr. *Hume.*) Do any of the sands below that, near the mouth of the river, shift?—They are shifting constantly.

1628. Do you mean without the bar or within the bar?—Just at the bar; the Seaman's Fraternity are always moving their buoys.

1629. You have not turned your attention to the bars outside so much as the harbour inside?—No.

1630. Is it your opinion that all these dykes and encroachments which you have pointed out on the river above the town should be removed in order to improve the navigation?—I would not go so far as to say they ought all to be swept away, because some of them are taking in ground which is already silted up almost to high water; and though in principle the smallest encroachment is bad, still I think the injury done may be extremely trifling.

1631. In principle you think every encroachment ought to be avoided?—Certainly. Sometimes you may encroach a little with advantage, because you may straighten the shore, and do more good by the straightening than by the abstraction of the water.

1632. By directing the current?—Yes; and I have recommended that to the Dundee Harbour Trustees. The proposed Perth Railway comes above the harbour; some persons objected to it because it abstracted water. I said to them, "Any injury done by that will be more than compensated by the good which will be done from straightening the channel."

1633. Strictly speaking, ought not compensation to be given by cutting away some projecting part of the bank, so as to admit the same quantity of water while you straighten the stream?—That would be a double compensation. I do not know whether they are bound to do it; but it was talked of. They were to be bound to cut away the point of rock at the Magdalen yard, which I recommended two years ago.

1634. As engineer to the Harbour Commissioners, are there any improvements or any measures that you would recommend, calculated to improve the harbour beyond those you have now suggested?—There are certain rocks that ought to be blown away.

1635. You would recommend the removal of all rocks?—Yes, as far as our funds would admit of it. I have been called upon to give a plan for a low water pier at the Beacon Rock, or on the outer wall, and I have recommended one to be built, a timber one, projecting out from the outer wall.

1636. Is there not a tendency of the silt to deposit at the rocks?—Yes, the silt deposits to some extent in the line of the rock.

1637. Do you think the removal of the rocks would sweep that away?—It would be a great advantage; but the expense would be so enormous, that I never thought of proposing that. Unless you take the rock down to a considerable depth, it will be more injurious; if you took it down just to low water, it would be more dangerous than it is now.

1638. (*Capt. Washington.*) Are not the Fowler, Beacon, and Drummond Rocks, lying just at the entrance of the basin, prejudicial to the harbour, not only in point of navigation, but as forming a slack on the flood tide, and thereby causing a deposit of silt?—Yes, it would be a great advantage to have them removed.

1639. Are you aware of any very great freshes in the river Tay during the last ten years that can have caused an increased depth of ten feet of water at the entrance, as you will find by the Admiralty survey of last September?—I do not think there has been a fresh in the Tay that

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could affect the bars materially; I think that any effect from a fresh at the bar is a mere bagatelle compared with the scouring of tidal water.

1640. Then are you not of opinion that the increase of depth at the entrance of the river may be fairly attributed to the dredging above Newburgh, and the removing 840,000 tons of soil from its bed?—No; I do not think that any works in the upper part of the Tay could have had any such effect.

1641. Has not the removal of that quantity of soil admitted fully one million cubic yards more of water on every tide since its removal?—I do not know that it has admitted any water, because most of it is put into the side to narrow the river.

1642. (Mr. *Hume.*) Has it been laid within high water mark?—Yes; Messrs. Stevenson's plan is to narrow the river to one deep channel, in the same way as they have been doing in the Clyde. In one place, where there was an island in the middle, they shut up the channel. I have no doubt that more water goes up now than formerly, but not to the extent of the soil that has been lifted, because a good deal of what was lifted was put down below high water mark.

1643. Then, all that is lifted from the bed ought to have been laid outside the high-water mark?—I do not say that, because it may be very beneficial to narrow and straighten the channel.

1644. (*Capt. Washington.*) From your experience as resident engineer at Dundee, are you of opinion that it would be desirable to have a public Board, such as an Harbour Board in connexion with the Admiralty generally, to superintend harbour affairs?—If that Board was to look after encroachments and the general interest of the public harbours in the kingdom, I think it would decidedly be beneficial.

1645. (Mr. *Hume.*) Have you ever entertained opinions respecting encroachments of the river different from what you now entertain?—No; I never have since I considered the matter at all.

1646. Have you given in any plans for harbours that would have shut out the tidal waters to a considerable extent?—Not to a considerable extent. There was a design for a very small harbour for Mr. Alleo, of Errol, which I gave about 12 years ago. The principle of that was bad, in so far that it would have excluded some water, not directly, but by its ulterior affects in silting up the shore.

1647. In the other harbours in Scotland where you have been consulted, have your opinions been such as you have now stated, that every impediment ought to be removed, and the tidal water admitted as far as possible?—Certainly; but it must be understood that the docks of Dundee have been an encroachment on the river; they are taken from the river.

1648. Were they not rather in a bight of the river?—Rather so; we have no other place to put them, as there is only a very narrow strip of level ground at Dundee, between a ridge of hills and the sea, and this is all covered with buildings, which would be very expensive to purchase.

1648*a*. (*Chairman.*) What tidal rivers and harbours have you examined and reported upon?—Leith Harbour, Dundee Harbour and River Tay, River Earn, Montrose Harbour and River South Esk, Arbroath Harbour, Inverness Harbour and River Ness, Nairn Harbour and River, Kirkaldy Harbour, Burgbead Harbour, St. David's Harbour, Warkwortb Coquet Harbour, &c., &c.

1648*b*. In the course of your experience, have you been enabled to lay down any principle which is generally applicable to the improvement of tidal rivers?—No; circumstances vary so much, that a principle which may be advantageously applied to the improvement of one river may not be at all applicable to another.

1648*c*. What are the chief obstructions to the propagation of the tide which are generally found to exist?—Straits, sinuosities, and fords or shoals.

1648*d*. Explain in what way these obstructions operate?—A strait acts like the narrow neck of a bottle, and sometimes prevents the river or estuary above it from filling or emptying so as to acquire the level of the ocean either at high or low water, as in the case of Old London Bridge.

Sinuosities cause the tidal wave to expend its force in striking against the concave side, and shoals or fords act generally in a similar way to a strait, although the tide may, to some extent, overcome the obstruction so formed, by rising up to a higher level over them.

1648*e*. How can such obstructions be most effectually removed?—When the sides of a strait consist of rock, as at Brougbty Ferry in the Tay, or at Seacombe in the Mersey, it is difficult and may be impossible to widen it or to remove the obstruction, and the only thing that can be done in such a case is to prevent an aggravation of the evil by any farther encroachment; and if the projecting point cannot be cut away, it may sometimes be made less an obstruction by giving a good curve to the line of shore, so as to make the contraction gradual and like a trumpet mouth on both sides, instead of being abrupt.

Sinuosities may generally be removed by dredging off salient points and filling up bays: fords or shoals generally by dredging, if the bottom be gravel; but they may require to be removed by diving-bells, coffer-dams, or by temporarily changing the channel of river, if the bottom be rock; and if the bottom be sand or mud, it may frequently be removed by properly directing the scour of the river itself: but this may be prejudicial unless there is a strong tidal current across the mouth of the river or harbour, as otherwise the mud or sand carried down by the river would be likely to deposit at the mouth and to form a bar.

1648*f*. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down in freshes, or to tidal waters?—At the mouth of the river to the tide, but gradually getting less so, and more due to the river as you ascend, until the action of the tide finally ceases.

The action of the tide at the river mouth is still more preponderating when the river widens

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out into an estuary, and this, I think, is always the most favourable condition for keeping the bar of a river clear.

1648*g*. Is there more to fear for our river harbours from the detritus brought down by the stream, or to silt carried into them from the sea?—That depends on the nature of the river, and of the position of the harbour or river mouth. A river, such as the Ness, which is the outlet of a large lake, brings down little or no detritus, as that has been all deposited in the lake, but generally, in my opinion, there is more deposit in river harbours from the river than from the sea. Rivers which take their rise in mountainous districts generally bring down large quantities of gravel, and those which flow through flat alluvial countries a great deal of mud, and frequently these conditions are blended, and gravel, sand, and mud are all brought down together. A river which empties on a shore which is constantly being undermined and washed away by the action of the sea, such as a chalk cliff, is more liable to be obstructed by the shingle brought by the sea than by its own detritus.

1648*h*. Can you state any instances in which works designed in conformity with the principle you have laid down have been productive of beneficial effects?—The Clyde, the Tay, and many other rivers, have been materially improved and deepened by the proper application of dredging and straightening their channels.

1648*i*. Can you furnish the Commission with any data as to the cost of dredging harbours or rivers?—At Dundee, dredging mud or sand, and heaving it up and running it along railways to embank ground, costs *7d.* to *7½d.* a cubic yard, including a per centage on the dredging machinery. When the stuff is dropt from hopper punts, which is done until the ground gets too high for the punts to float over it, the cost is 1*d.* or 1½*d* per cubic yard less. I could state the prices of dredging at other places, some more and some less than at Dundee, but not of my own knowledge.

1648*j*. Are you of opinion that it would be beneficial to have a Central Harbour Board established in London in connection with the Admiralty, that should have a general supervision and control over the improvement and management of all harbours of the United Kingdom?—Yes. I am of opinion that it would be highly beneficial to have a central board of supervision and control over harbours to prevent obstructions and encroachments, &c., because such a board would generally be competent to decide at once whether any projected work was objectionable or not, and so save expense of litigation; whereas the ordinary courts, when a complaint is made to them, can only be guided by the opinions of engineers or other competent persons to whom they must remit the question.

Wednesday, June 4th, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Capt. Sir Gordon Bremer, K.C.B. Mr. Hume, M.P. Mr. Godson, M.P.	Capt. Beaufort, R.N. Mr. A. Chapman, M.P. Capt. Washington, R.N.

Mr. *Adam Burnes* sworn and examined.

Mr. *Adam Burnes.*

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[*Plans and Sections of the embanked Lands near Old Montrose, by Messrs. Blachadder and Rendel,* 1842, *and Mr. G. Buchanan, C.E.,* 1843, *were laid on the Table.*]

1649. (*Chairman.*) What is your profession?—I am a solicitor and clerk to the trustees of Montrose Harbour.

1650. You reside at Montrose?—Yes.

1651. Are you acquainted with the state of the suit which is pending between the trustees of Montrose Harbour and Sir James Carnegie?—I am.

1652. Will you state to the Commission the present position of that suit?—In June, 1837, an Act was passed for the improvement of the harbour of Montrose, and vesting the management in trustees; it was formerly in the hands of the corporation, who did not pay sufficient attention to matters relating exclusively to the harbour. That Act was passed in 1837, but the trustees were not enabled until 1839 to proceed with their works. In that year the Wet Dock was commenced; the plans were submitted to Mr. James Walker, of London, civil engineer, who approved of the plans generally, and of his own accord suggested to the trustees to be very vigilant in preventing encroachments on the estuary or bason of Montrose, which he described as "the lungs of the harbour." In September, 1841, Sir James Carnegie, of South Esk, commenced an embankment on the estuary for the purpose of diverting the channel of the river of South Esk. A committee of the trustees met at the embankment with Mr. Lyall, Sir James Carnegie's factor or agent, at which I was present. Mr. Lyall explained that the object of the embankment was to divert the channel of the river. The committee did not object to the wall. The minute was as follows:—"The committee, after consulting Mr. Leslie, are of opinion that the present operations are not in themselves objectionable, but that any encroachments made to gain ground from the basin ought to be resisted, and that it is therefore proper to watch the proceedings of Sir James Carnegie."

1653. (*Mr. Hume.*) Was this an intimation to Sir James Carnegie against any encroachment on the land?—Yes; and the committee requested Mr. Leslie to prepare a plan, showing the proposed new channel of the South Esk, for the information of the trustees.

1654. Did he submit that plan?—He did.

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1655. Did he point out that any encroachments would be injurious to the navigation?—He pointed out that that part of it for diverting the channel would not be injurious. In June, 1842, information was sent to me when I was in Edinburgh, that Sir James Carnegie was rapidly extending the embankment to the southern shore, so as to enclose and gain ground from the estuary. I instantly remonstrated, by letter, with Mr. Lyall; and upon my return to Montrose I personally attended at Kinnaird Castle, the residence of Sir James Carnegie, and intimated a notarial protest against his proceedings, by order of the trustees.

1656. Is that the usual mode of public bodies, intimating their opposition to any proceeding?—It is. The party is warned that he proceeds at his highest peril. Simultaneously the trustees applied to the Lord Ordinary at the Court of Session in Edinburgh, for an injunction or interdict against this proceeding. That interdict or injunction was obtained about the 28th of June, 1842; and on the following day a special messenger intimated the interdict to Sir James Carnegie. The works were, notwithstanding, rapidly completed.

1657. What has been the effect of those works on the tidal lands?—The effect has been in the meantime to enclose about 62 acres of ground, and to exclude a very large quantity of water. The trustees at the same moment memorialised the Admiralty, and the Secretary (the Honourable Sidney Herbert) desired me to suggest to the trustees to consult an engineer of eminence, and particularly pointed out Mr. Rendel, who was then in Dundee, about some works on the part of Government. Mr. Rendel accordingly inspected the works in the presence of Mr. Leslie (the harbour trustees' engineer), Mr. Blackadder (Sir James Carnegie's engineer), and myself; and he afterwards required the two engineers to concur in a statement of facts and to subscribe a plan. This is a sketch of the plan which the two engineers submitted to Mr. Rendel, at his request. (*Plan laid on the table.*)

1658. Was that sketch of the embankment last enclosed by Sir James Carnegie agreed upon as to its limits by the two engineers?—It was. Mr. Rendel did not frame his report until the month of December. He transmitted it in duplicate to the Admiralty and myself as for the harbour trustees. In that report he stated that the complaint of the harbour trustees was well founded; but he recommended that the embankments should be allowed to remain, provided Sir James Carnegie adopted the alternative of making certain excavations higher up the river, on purpose to allow a greater quantity of water to come up, and in some measure to compensate for that excluded by the embankment. After obtaining the sanction of the Admiralty to this arrangement, I, on the part of the trustees, and as authorised by them, addressed a letter to Sir James Carnegie, dated 20th December, 1843, and requested him to state, within a certain number of days, whether he was prepared to adopt the course pointed out by Mr. Rendel, and sanctioned by the Admiralty, which letter was acknowledged on the 21st of December, 1842.—(*For the Letters, see Appendix.*)

1659. (*Capt. Sir G. Bremer.*) Did you make any further application?—Sir James Carnegie not having given any answer, the interdict proceeded to be heard in the court of session.

1660. (Mr. *Hume.*) It has been stated by the Lord Advocate, than an injunction was obtained. Were you present, or can you state the nature of that injunction?—Lord Fullerton, the Lord Ordinary, who decided the case, held that the embankment had proceeded so far, that that form of procedure—injunction, which is a summary one, was not suitable to the case, and therefore that it required to be tried in a more formal manner, the merits were entirely reserved, and there was no opinion given on the merits of the case. These are the words of Lord Fullerton—"The embankments complained of are already completed, with the exception of certain works intended only to protect them from external injury." Sir James Carnegie offered security to meet any damage that should occur.

1661. Was that security granted?—It was not; Sir James Carnegie was ready to grant it; and if it has been stated it was granted, it was stated on my authority, for I understood it to be granted from the correspondence.

1662. Were there any other legal proceedings after that?—No other legal proceedings have since been taken by the trustees. A good deal of correspondence passed with a view to induce the Admiralty to take up the case.

1663. Why did you apply to the Admiralty to take up your case?—Because the Wet Docks had been just completed at a great expense, and the money raised upon the personal guarantee of a number of gentlemen, who derive no pecuniary benefit, and we have not the means of prosecuting proceedings in a court of law.

1664. Was any memorial forwarded to the Admiralty, and what was their answer?—A memorial was forwarded to the Admiralty, and the Admiralty directed Mr. Robson, Admiralty solicitor, to inquire into the circumstances, and after that, the matter was remitted to the Lord Advocate to report upon it.

1665. Have you any knowledge of the reports of Mr. Blackadder and Mr. Buchanan?—Mr. Blackadder concurred in a joint statement of facts with Mr. Leslie to Mr. Rendel, and signed the plan which Mr. Rendel proposed, after which Mr. Rendel framed the plan which accompanied his report to the Trustees and the Admiralty.

1666. Did he give any report as to the injurious tendency of enclosing the tidal water in the harbour?—Mr. Blackadder's report as to that was not asked; Mr. Rendel merely wished him to concur in the facts upon which he was to form an opinion.

1667. Now with respect to Mr. Buchanan, are you aware what his report was?—Mr. Buchanan was employed by Sir James Carnegie latterly, and I believe gave an opinion that it was not injurious to the harbour.

1668. Can you state of your own knowledge, that during the time you have acted as clerk to the Montrose Harbour Commissioners, they have throughout been anxious to guard against any encroachment on any portion of the basin or harbour covered by tidal water?—They have

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been most anxious; in fact, a small quantity of mud was lately put down by the Bridge Commissioners, and the Harbour Trustees resisted it, and ordered its removal.

1669. Do you know whether the Commissioners would have prosecuted their suit against Sir James Carnegie, so far as to compel him to remove these encroachments if they had had funds at their disposal so to do?—I am certain they would.

1670. And it is only from their funds being engaged in finishing the works, and even money borrowed on the private credit of individuals, that they were prevented from going on?—It is. They have expended about 42,000*l.* within the last few years for completing the works; these are not the property of any joint stock company, where individuals can derive profit, but a public harbour of which they are mere trustees, and from which they derive no pecuniary benefit.

1671. What are the revenues arising to the Harbour Commissioners from their charges?—About 3,400*l.* a year; they have averaged that amount since May, 1839.

1672. How much of that is applied towards the payment of money borrowed?—The amount of debt is about 40,000*l.*, and the interest is about $3\frac{1}{2}$ per cent.

1673. Did you not apply lately to the Treasury to obtain from the Exchequer Bill Commissioners a reduction of the amount of interest to that which they paid, with the view of assisting you in your proceedings?—The trustees applied lately to the Treasury to authorize the reduction of the rate of interest. The Treasury replied they could not do it, but agreed to authorize the assignment of the mortgage they hold to another party. The trustees applied to various banking establishments, and the money was offered for two years at 3 per cent.

1674. Have you any further observations to make respecting the state of the harbour?—I would add, that I believe the harbour would be very much improved if what is called the Stone adjoining Scurdy ness, on the south side of the entrance to the eastward were removed.

1675. (*Capt. Washington.*) Until the Stone can be removed, would not a good beacon be very serviceable?—Most undoubtedly it would; and Mr. Walker, the engineer, suggested that to the trustees.

1676. Why have not the trustees erected that beacon?—Because their funds are quite inadequate.

1677. Is not such a beacon quite within the business of the Commissioners of Northern Lights?—I believe so.

1678. Is not the North Carr Beacon off Fifeness erected by the Commissioners of Northern Lights?—I believe so.

1679. (*Mr. Hume.*) Are you able to state whether any encroachments have been made upon the tidal waters of Montrose Basin, or the neighbourhood, by Sir James Carnegie's predecessors?—Yes, and they are correctly shown on the plan.

1680. To what extent, and in what years?—There was an embankment made in 1817, one in 1830, and a third in 1831.

1681. What is the number of acres?—I should think at least 60 acres each. I beg to give in a tracing of a plan drawn by Mr. Buchanan, dated in 1843, he being Sir James Carnegie's engineer, with all the depths marked upon it.

[*The Witness withdrew.*]

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Mr. *David Stevenson,* F.R.S. Edin., Civil Engineer, sworn and examined.

[*Mr. Stevenson's large plans and sections of the Tay, the Forth, Dornoch Frith, the Ribble, the Lune, and the Dee, &c., were exhibited*]

1682. (*Chairman.*) What is your profession and place of residence?—Civil engineer, residing in Edinburgh.

1683. How long have you been acting as a civil engineer?—About eight years, in partnership with my father and brother; and before that I was about three or four years acting as a resident engineer.

1684. What tidal rivers and harbours have you examined, and reported upon?—I have surveyed and reported on the Dee, in Cheshire; the Ribble, Lune, and Wyre, in Lancashire; the Trent and Fossdyke, in Lincolnshire; the Earne, in Ireland; and the Tay and Forth, in Scotland. I have designed and executed extensive works on some of these rivers. I have also designed and executed various harbour works in Scotland and Ireland, and have had occasion to survey in the course of my professional employment several of the Firths and Bays of Scotland.

1685. In the course of your experience, have you been able to lay down any principle which is generally applicable to the improvement of tidal rivers?—I have; the rivers in this country are comparatively small, and their waters can only be navigated when under the influence of the tide. They may, therefore, be said to be small creeks kept open by the joint action of the fresh-water stream and the tidal influence. The fresh-water stream cannot be materially increased by any work of art; and therefore my opinion is, that the principle that should be kept in view in improving such navigations is to *increase the duration of the tidal influence*, by removing obstructions to the progress of the tide along the river's bed and banks.

1686. What are the obstructions which are generally found to exist?—The causes which are most frequently found to operate in producing retardations in the propagation of the tide are the circuitous routes of the channels of rivers; the projection of obstacles into the stream, such as jetties, &c.; the erection of weirs, and especially the slope of the river's bed, and the downward flow of the fresh water occasioned by it.

1687. Can you explain in what way these obstructions operate?—When the tidal wave

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enters a river its velocity is modified by the obstruction it receives, and in all cases with which I am acquainted the rise of the tide in the lower parts of the river is more rapid than its propagation, so that the water becomes heaped up in the lower parts of the river and acquires a much higher level than the water in the upper part of the river; or, in other words, at low-water there is a slope from the sea *upwards*, but at other periods of tide there is a slope from the sea *downwards*, caused by the obstruction to the propagation of the tidal wave and the consequent heaping up of the water. Thus, in the Dee for example, there is, at low-water, a fall of 11 feet from Chester to Flint; but on one occasion I found that although the tide had risen 18 feet 10 inches at Flint it had not commenced to rise at Chester, and at the time alluded to the level of the water at Chester was 7 feet 10 inches *below* that at Flint, which is situated 12 miles further seaward. The more rapid the tide and the greater the rise, the more clearly is the obstruction to the tidal wave exemplified, as shown by the following spring and neap tides taken from the Lune and Dee.

River Dee, Cheshire.					River Lune, Lancashire.				
Date.	Rise of Tide at Flint.		Maximum Fall from Flint to Chester.		Date.	Rise of Tide at Glasson.		Maximum Fall from Glasson to Lancaster.	
1839.	Ft.	In.	Ft.	In.	1838.	Ft.	In.	Ft.	In.
May 21 . .	14	0	3	8	August 29 .	12	1	1	1
May 23 . .	15	6	4	5	August 31 .	12	9	1	6
May 25 . .	16	4	5	8	September 1 .	15	4	2	0
May 29 . .	18	0	6	6	September 3 .	19	8	2	10
June 10 . .	19	8	7	10	September 5 .	23	2	3	2
					September 6 .	23	6	4	4

1688. How can such obstructions be most effectually removed?—The obstructions are various, and the means to be employed depend on their nature. If there are impediments in the beds they can be removed, either by dredging, if the material is such as can be dredged, or by excavation, by means of coffer-dams, if it is of a harder nature. If the obstruction consists of projections from the banks of the river, these may generally be removed by very simple means, and the low-water channel may often be advantageously directed by means of low walls. As a general rule it may be stated, that the obstructions to the tidal wave may be removed by reducing the slope of the bed of the river, and all these works have a tendency to effect this.

1689. Have you already been concerned in removing obstructions of this nature in rivers you have been employed on?—Yes, pretty generally; on the Tay and on the Ribble, in particular, I have removed many such obstructions.

1690. Can you furnish the Commission with any data as to the cost of dredging?—From 5*d*. to 6*d*. per cubic yard is a fair price for dredging gravel, including all expenses.

1691. Are you of opinion that depths in rivers and their power of scouring are chiefly due to the volume of water brought down in freshes, or to the tidal waters?—I should say to the tidal waters.

1692. Which is most to be feared in our tidal rivers, the detritus brought down by the stream, or carried into them from the sea?—Something must depend on the situation; but in general I should say, so far as my experience goes, that the detritus brought down by the fresh water is more to be feared.

1693. (*Capt. Beaufort.*) Does that observation apply principally to the east or the west coast?—It is general and refers to the courses of tidal rivers, not to bars; not, for example, to the bar of the Mersey or the bar of the Tay.

1694. (*Chairman.*) Can you state any instances in which works designed in conformity with the principle you have laid down have been productive of beneficial effects?—Yes, the Tay and Ribble are both examples of it. The state of the Tay navigation before the operations were commenced was as follows. At low water the depth was about 1 foot 9 inches, and at high water about 11 feet 9 inches on several fords or shoals, which existed between Perth and Newburgh, namely, Kirwhinnel, Seggieden, Millhurst, Sleepless. These different fords were deepened by means of dredging, and three islands at the three upper fords were connected to the shore by means of embankments. Besides that, a great many boulder stones were removed from the bed of the river, some of them 50 tons weight, and in some places the banks were cut, so as to widen the river. The present depth is about 5 feet at low water, and 15 feet at high water.

1695. (Mr. *Hume.*) Is not every embankment calculated to exclude the flow of the water?—No; in this particular situation I conceive it was not; at each of those islands a *ford* or shallow was formed from the currents being diverted by these islands; and in order to maintain a proper navigable depth, as well as to clear away those fords, to enable the tidal wave to be propagated up the river with sufficient speed, and a greater body of tidal water to be admitted, we found it necessary to divert the whole of the currents, both of the flood and ebb tide into the main channel of the river, by means of the embankments.

1696. Do you by that means lose any surface that otherwise would have been covered by tidal water?—We have not yet lost any surface, excepting that occupied by the embankment; but at the back of these islands the process of silting is going on.

1697. Can you give any compensation by deepening elsewhere, so as to continue or increase the volume of tide?—I think we have already, by our operations, given ample compensation for what has been or will be shut out by these embankments.

1698. Have you obtained a straighter current, and a deeper channel?—Certainly.

1699. (*Chairman.*) Will you state the present tidal phenomena as compared with those

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before the operations were commenced?—The fall on the bed of the river from Perth to Newburgh, before the operations commenced was four feet, and now that fall is only two feet. The passage of the tidal waters from Newburgh to Perth, in 1833, a distance of 8·56 miles occupied two hours and thirty minutes, being at the rate of 3·42 miles per hour; but it is now propagated between the same places in one hour and forty minutes, being at the rate of 5·13 miles per hour; giving a decrease in the time of fifty minutes, and an increase in the spee of the first wave of flood of more than $1\frac{5}{8}$ mile per hour since the operations commenced.

1700. By whom were these observations made, and when?—They were made partly by myself and partly by assistants under my direction. They have been made at various times since 1833, and we have found a gradual improvement in the tidal phenomena; and the last result which I have just stated was obtained from observations made in 1844.

1701. Have these tidal phenomena been apparent, and increased in proportion as you increased your operations and removed the difficulty?—I think so.

1702. Have you any doubt these phenomena and changes have arisen from the operations you have carried on?—Not the least whatever. As a further proof of the change which has taken place, I may state that in 1833 the spring tides at Perth flowed for two hours and twenty minutes, and ebbed for seven hours; and at low water the river ran at its natural level for one hour and forty-five minutes; but now the tide flows three hours and ten minutes, ebbs seven hours, and stands at low water only one hour, being an increase in the duration of flood of 50 minutes, and a decrease in the time at which the river is uninfluenced by the tide of 45 minutes.

1703. How do you account for that change?—Formerly, as I stated, the tide occupied two hours and thirty minutes in ascending from Newburgh to Perth. The flood at present arrives at Newburgh at the same time as it did before, but it arrives at Perth 50 minutes sooner; so that the length of time during which the tide is actually rising at Perth is increased, and the length of time during which it is falling is nearly the same, the river running in its natural state a proportionally shorter length of time. The difference between the termination of the ebb and the beginning of the flood is lessened by 45 minutes.

1704. How do you explain that?—It is occasioned by the low water level being lowered at Perth, which causes the flood to come more rapidly from Newburgh to Perth than formerly, so that it begins to rise sooner than it did before.

1705. Is that caused by the deepening and removal of the obstructions which formerly existed?—Entirely. I would add, as a still further proof of beneficial change, that from calculations which I have made, I find that an additional quantity of tidal water, amounting to at least a million of cubic yards, passes every tide above Newburgh.

1706. How have you ascertained that?—By a calculation founded on the present section of the low water line of the river compared with the former section in 1833.

1707. Does that section run through the whole distance between Newburgh and Perth that increases in the volume?—It is an increase due to the whole space between Perth and Newburgh.

1708. (Mr. *A. Chapman.*) Does the tide rise higher than it did at Newburgh and at Perth?—No; the level of the high water is much the same at these points, but it sinks lower, owing to the bed of the river having been lowered, and therefore there is an additional range of tide.

1709. (*Chairman.*) What was the former state of the Tay navigation as to shipping coming up to Perth?—Formerly vessels generally unloaded part of their cargo at Newburgh, and even with that they were sometimes two spring-tides in getting up to Perth on account of the obstructions, unless they were fortunate in their tides. Now, vessels of the same class come up with perfect ease in one tide to Perth from Dundee without unloading.

1710. Do you consider the Tay capable of further improvement?—I do. I conceive that the Tay, by judiciously laid out works, could be easily deepened to 18 or 20 feet at high-water spring tides up to Perth. The average slope of the bed from Perth to Balmbreich is still upwards of 5 inches per mile.

1711. Will you state what the nature of those proposed works would be, and in what part of the river they would be carried on?—The works proposed consist of dredging in the upper part of the river from Perth to Newburgh, and in the erection of a low rubble wall from Newburgh downwards to a point, probably at Flisk, a distance of about 6 miles. The estimated cost is between 45,000*l.* and 50,000*l.*

1712. (Mr. *Hume.*) What height of wall?—It might be made as high as high-water mark without prejudicing the navigation, but it would not be necessary to make it that height.

1713. What purpose do you expect to answer by that?—We expect to be able to regulate the channel from Newburgh to Flisk, which at present is very much distorted and unequal in depth, chiefly on account of certain jetties which have been projected from the shore, and also to reduce the slope from Newburgh downwards (which is at present about 10 inches per mile) and thus cause a further acceleration of the tide between Dundee and Perth.

1714. Are these jetties by the proprietors on the shore an encroachment on the water?—They are.

1715. Do you consider you have the power of removing them now?—We have by a late decision of the Court of Session.

1716. For what expense can that be done?—The proprietor is obliged to remove them. The estimate I do not know.

1717. Have any notices been given to the parties who erected the jetties to remove them?—Yes, and they are now in the process of being removed.

1718. After those removals, you would erect the rubble wall, which you have stated?—Yes.

1719. Do you expect by straightening the course to increase the current, and thus deepen the channel along the wall?—Yes, I expect to equalize the current, to get deeper water, and to facilitate the flow of the tide.

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1720. Do you contemplate dredging to remove those banks which now appear to occupy the southern part of the channel?—No; but it may be necessary to dredge in front of the wall which we propose to erect, in order to remove the fore-shore.

1721. What width do you propose to deepen that channel beyond the wall running in the line you pointed out?—We do not contemplate much dredging or much widening between Newburgh and Flisk Point, only such as is necessary to remove any hard obstructions which cannot be removed by the current of the tide.

1722. Would that give you the 4 feet addition in the upper part of the river?—These operations, in connexion with the works proposed in the upper part of the river, would do so, and would also increase the velocity of the tidal wave up to Perth, and the influx of tidal water.

1723. Have you any other contemplated improvements?—No.

1724. What is the depth of water from Flisk downwards for vessels in ordinary tides?—In no place less than 30 feet at high-water spring-tides between Flisk and Invergowrie; below that, the Firth is from 6 to 9 fathoms at high water.

1725. If that improvement was made, would the River Tay be navigable to Perth, by vessels drawing 18 feet, and thus render the unloading the cargo at Newburgh or any other place unnecessary?—Certainly; and in addition to the greater depth the shipping would have the advantages produced by the increased duration of tidal influence, which in proportion to its amount, prolongs the period during which the navigation is available for the passage of shipping, and thus tends directly to improve it.

1726. Have you found in your intercourse with the river any difficulty in persuading the proprietors to remove encroachments in the river?—Yes; and it has only been by constant appeals on the part of the Conservators of the River and Navigation Commissioners to the Courts that they have been enabled to prevent encroachments. The law process connected with the removal of these jetties was very tedious and expensive.

1727. Is it understood that the last decision to which you alluded has settled the law as regards the encroachments generally on the Tay?—I do not know that there is to be any appeal from the Court, but of course there may be an appeal to the House of Lords.

1728. Would you, as an engineer, recommend the removal of all obstructions by way of jetties, or otherwise, that you consider to be an impediment to the navigation?—Certainly.

1729. (*Capt. Sir G. Bremer.*) I think you have said that these obstructions are in process of removal, in consequence of the decision of the Court?—Yes.

1730. (Mr. *Godson.*) Have these decisions enabled you to remove any that have been erected more than 20 years?—I think not.

1731. Are you sure that you can remove any which are supposed to have been erected 40 years?—No; I suspect not.

1732. Then the result is, as far as your impression goes, that all that have been removed by order of the Court have been erected within 20 years?—I believe that is the state of things.

1733. (*Capt. Washington.*) Under whose superintendence or control is the buoyage of the Tay from the lower limits of the Perth Commissioners upwards?—Under the magistrates of Perth, as Conservators of the river.

1734. Are there sufficient buoys for the safe navigation of the river?—I have not heard any complaints.

1735. Do you think that the embankment directing the current you have proposed might tend slightly to carry away the lower end of the Middle Bank that lies so inconveniently between Dundee and Newport?—The embankment in itself would not, I think, if it stopped at Flisk; but if the result of the embankment is, as I anticipate, to get a still greater amount of tidal water into the estuary, then, of course, that would have some effect on the bank as a scour.

1736. Do you know what is the nature of the Middle Bank; is it gravel, or sand, or mud?—I think sand.

1737. (*Capt. Sir G. Bremer.*) Have you ever contemplated the extension of the embankment you mentioned, as far as Balmerino?—No.

1738. Supposing it were continued as far as Balmerino, would not that have a considerable effect on the Middle Bank?—It would.

1739. Would you consider that a judicious measure?—No; it would tend to withdraw the water too much from Dundee. I think it would not be judicious, because the channel below Flisk is sufficient for all the purposes of the navigation.

1740. (*Chairman.*) What was the former state of the river Ribble?—Spring tides rose about six feet at Preston, and tides of 14 feet rise at Liverpool, did not rise at Preston at all. The depth of the navigation at high water of spring tides was only for vessels drawing about six feet. The vessels employed were lighters or flats, which got the cargoes from the vessels frequenting the port, at Lytham.

1741. What works have been executed, and what is the present depth and state of the tides?—About 30,000 cubic yards of rock have been excavated near Preston; about 800,000 tons of gravel have been dredged, and 7½ miles of low rubble walling have been erected in the lower part of the river, from a place called the Chain downwards. Those are all the works which have been executed hitherto; the dredging and walling are at present in progress, and the improvements effected of course are progressing also. I cannot state so definitely as I was able to do with regard to the Tay, the exact amount of improvement, but vessels of about 12 and 13 feet draught go up to Preston, which was formerly reached only by flats drawing 6 feet. The vertical range of the tide at Preston has been increased about 4 feet. I may state further to show the practical effect of the improvements that previous to 1840, as I mentioned before, the vessels were unloaded in the lower part of the river, and the goods brought up by lighters. In the first three months of that year (1840), no vessels, excepting flats, came

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up to Preston; in the first three months of 1841, 23 sailing vessels came up to the quays; in 1842, 37 vessels came up; in 1843, 61 vessels came up; in 1844, 66 vessels came up, and during the first three months of this year, 95 vessels have come up. These numbers I have received from Mr. Park, who conducted the greater part of the works as resident engineer. The dues have been nearly quadrupled since the commencement of the works.

1742. Are there any vessels that now unload a portion of their cargo at Lytham, as formerly?—Yes; the largest class of vessels that frequent the river, I believe, unload there.

1743. Do you know what proportion of the trade is so landed?—No.

1744. Do you know what is the tonnage of the largest vessels that can go up to Preston?—About 200 tons. I suppose the draft may be stated at 12 or 13 feet.

1745. Is the river susceptible of further improvement?—I think so by the continuation of the different operations at present going on. The rock excavation was carried to such a depth as to admit of the river being deepened to 20 feet. The excavation was done by cofferdams of peculiar construction which I designed for the especial purpose. I think, it could be deepened to the extent of from 18 to 20 feet up to Preston. In order to do that, it would be necessary to carry the excavation a little above Preston. There is rock in the upper part of the river above Preston, and we should excavate that, in order to give the tide a freer run up the river.

1746. (Mr. *Hume.*) How high above Preston does the tide flow at present?—About four miles and a half, or 21½ from the Irish Sea.

1747. Would the removal of the obstruction which you have now mentioned enable it to go further?—I think it would.

1748. And thus increase the volume of water for the downscour?—Yes.

1749. What expense has been incurred in doing the works you have now stated?—The whole works have cost, I think, about 47,000*l.*

1750. Have you any estimate of the expense which would be required to obtain that increased depth of water?—I have made no estimate of what would be necessary, in order to carry the depth to 20 feet.

1751. Are you still employed as engineer?—Yes.

1752. Is there any bridge at Preston, and is that bridge any impediment to the water-way?—It is an impediment, but not a bar to the improvements which I have sketched out.

1753. (Mr. *Godson.*) Are there not more than two or three bridges?—There are three bridges.

1754. (Mr. *Hume.*) Are the Commission to understand that your future improvements will have in view the removal of all impediments, not only below, but above Preston, with a view of increasing the tidal flow to have the benefit of the downscour?—Certainly.

1755. (*Chairman.*) Can you name to the Commission any other rivers in which you think improvements can be effected by similar works?—The Lune, the Forth, the Trent, and the Dee.

1756. Have you made any separate report on the several rivers you have now mentioned?—I have made reports, and have all the details with reference to the tidal phenomena of these different rivers.

1757. Are they mentioned in the reports?—Not fully; the reports are general.

1758. (Mr. *Hume.*) Can you, if the Commission require it, give a short statement of the circumstances you think requisite to be known respecting those rivers?—I can.

1759. (*Chairman.*) Can you point out to the Commission any rivers in the United Kingdom the navigation of which has been injured by artificial obstructions, placed in order to gain land, or for any other purpose?—Yes; the Dee is an instance of that; a great quantity of land has been taken in, to the extent, I believe, of about 4000 acres, by means of an embankment upwards of 7 miles in length, the line of which has been most injudiciously laid out as regards the navigation. A weir has also been erected at Chester, which rises 11 feet 6 inches above the bed of the river, dams up the water for 6 or 7 miles, and checks the flow of the tide above the town. The Lune is another instance where land has been taken in, and where weirs also exist and check the flow of the tide. On the Wyre there are obstructions On the Ribble the existence of jetties was very prejudicial when we first surveyed it.

1760. Are you of opinion that it would be beneficial to have a central harbour board established in London, in connexion with the Admiralty, that should have a general supervision and control over the improvement and management of all harbours in the United Kingdom?—I think it would be very proper. I am not now prepared to enter into details as to the construction of such a supervising board; but I may state that I think it would be beneficial, because the rivers of the country may, in my opinion, be considered as so many public highways belonging to the public, stretching into the interior in various directions; and the interests of the landed proprietors are certainly quite hostile in most instances to the interests of the navigation.

1761. (Mr. *Hume.*) By the word "hostile," do you mean that they are disposed to encroach on land now covered by the water, and thus impede the general navigation?—Yes.

1762. Have you found a general disposition, on the part of landed proprietors, to attend to their own interests in that way, instead of taking a general view of the public interest?—In some cases I have: in the case of the Tay, for example.

1763. Do you consider that there ought to be in every Local Board a portion of the Commissioners uninfluenced by property, and having their authority from, or being appointed by, the Admiralty to watch the public interest?—It would be a very proper measure.

1764. Would not such a Board, established a century ago, have tended very much to prevent injuries that now have been produced by encroachments?—I think there is no doubt of it.

1765. And will the future benefit of the navigation generally be promoted by the establishment of some such supervising authority?—I think so.

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1766. Do you consider the authority should be to know all improvements or alterations in harbours before they are commenced as a means of preventing evil, as now done, and only noticed after their consequences are seen?—Yes.

1767. Are there any other suggestions you can offer to the Board as a means of improving the navigation generally of tidal harbours?—No; I think such a supervision would answer all the ends in view.

1768. Are you acquainted with the embankment that has been begun by Sir John Richardson on the north side of the Tay, as stated in his letter to the Commission of the 28th of May?—I am, if the embankment referred to is that extending from Cairnie Pier downwards.

1769. Will you explain the nature of it?—Sir John Richardson was permitted by the Perth Harbour Commission to deposit materials on a line which was approved of by us (the engineers), for the purpose of directing the current more favourably down the south channel of the river, and also for the purpose of improving certain fishing-stations belonging to him which our works had destroyed, and for the produce of which the Commission was responsible by the Act of Parliament, by which they were bound to compensate for damages. I may state, that on account of the responsibility of the Commission for all damage done to fishings we had very great difficulty with different fishers on the river, and were glad to deposit the stuff for making up fishing-stations, which had been destroyed in places where probably we should not otherwise have done it.

1770. What is the nature of the embankment referred to in the letter, and what do you contemplate as the effect of that embankment?—I am not prepared at present to answer that question.

1771. (*Chairman.*) Have you surveyed the parts mentioned in the Memorial of the Commissioners of the Forth Navigation to the Lords of the Treasury on the 3rd June, from Stirling to Alloa?—Yes.

1772. Will you describe the river?—Between Alloa and Stirling there are seven fords: they consist for the most part of boulder-stones embedded in clay, and at present form great obstructions to the navigation by reducing the depth. The scheme which we pointed out was the deepening of these several fords, and in that way we propose to obtain a depth of 13 or 14 feet of water up to Stirling, which will be sufficient for the class of vessels that navigate the Forth. At present the depth is about 10 feet; we gain 3 feet. The uppermost ford is called the Town's Ford: it is 2500 feet in length, and we propose to deepen it to an average extent of 2 feet, which will give a depth of 13 feet at high-water ordinary spring tides. The next is called the Abbey Ford, which is 1400 feet in length, and we propose to deepen that also 2 feet, giving 13 feet at high water. The next is called the Sow Ford, which is 400 feet in length, and we propose to deepen it 1 foot, which will give 15 feet. The next is Manor Ford, which is 1500 feet long, and it is to be deepened 1 foot 6 inches, which will give 16 feet. The next is Bandeath Ford, which is 1500 feet long, and it is to be deepened 1 foot, giving 18 feet. The other is Cambus Ford, which is 2800 feet long, and is to be deepened 1 foot, giving 20 feet. The lowest is Throsk Ford, which is 350 feet in length, and it is to be deepened 1 foot 6 inches, which will give 22 feet. The depths to be gained will enable vessels to have sufficient water over the lower fords at ½ or ¾ flood, and to reach Stirling in one tide.

1773. (Mr. *Hume.*) Have you estimated what will be the expense?—The total expenditure for the deepening of the fords is 9404*l.*

1774. Are you able to ascertain when these were formed, and by whom?—My own impression is that they are natural fords. Some of them may be artificial fords; but they are so numerous that they are not likely to be all artificial. My opinion is they are what is called whin dykes, many of which traverse the valley of the Forth.

1775. In your survey did you find on the banks of the rivers any embankments or encroachment of what was formerly land covered by the tide?—Alloa and Tillybody Islands are surrounded by embankments.

1776. What extent of land do they now form, gained by these enclosures?—A considerable extent, but I do not know precisely.

1777. Are the levels of the land on those two islands below the level of high water spring tides now?—I believe them to be so.

1778. Are there not in other parts of the river higher up many embankments, which have excluded the tidal waters?—There are.

1779. Could you estimate the amount of those enclosures between Alloa and Stirling?—Not without a special survey.

1780. Has any survey been made that you are acquainted with?—Not with that object in view.

1781. Have you seen any ancient map of the River Forth?—No; I should state that the Forth throughout its whole course, from Alloa to Stirling, flows through what is called a *carse*, consisting of low flat land. An enormous extent of land would be flooded were it not for these embankments.

1782. Have these embankments, in your opinion, greatly affected the flow of water to Stirling?—The tendency is to affect it; but they have been erected now so many years that I cannot say what was its former state.

1783. Do you know whether the depth of water at Stirling, at any former period, was more than it now is?—No.

1784. How high above Stirling does the water flow?—To the Cruive, which is about 4½ miles above Stirling.

1785. Is it impeded there by any dam or impediment?—It is impeded there by a natural barrier and a dam.

1786. For what purpose is that dam?—For the Craig Forth Mills.

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1787. Can you state how high the tide rises on that dam, and how much higher it would flow if that dam was removed?—I think it rises about 4 feet there.

1788. Do you know how long Craig Forth Mills have been erected?—No, but they are very ancient.

1789. Did you examine so as to ascertain, if that was removed, what the effect on the tide would be?—No, not specially; but it would increase the influx of tide unquestionably.

1790. Do you contemplate any other improvement, except the removal of the fords, in the statement you have now given?—Nothing farther upon the estimate of 9404*l*.

1791. Are there any other projections or impediments to the flow of the water up to Stirling that could be removed with benefit to the navigation?—There may be some points where the river is probably too narrow, and some of those might be removed with advantage to the navigation.

1792. Looking at the course of the river from Stirling to Alloa, has not it been much narrowed by the general system of encroachment by banks throughout its whole length?—I should say that it has.

1793. Is it your opinion that the navigation up to Stirling has thereby been injured?—The tendency has been decidedly to injure it; but I do not know from my own knowledge that it ever was any better.

1794. (Mr. *Godson.*) How many miles by the river is it from Stirling to Alloa?—10½.

1795. How much by land?—7½ by the road.

1796. (Mr. *A. Chapman.*) Would it not be advisable to make a cut here and there?—You would lose a good deal of tide water if you cut off the different bends. The principal objection, however, is on the part of the landed proprietors, and the proprietors of the fisheries.

1797. (Mr. *Hume.*) Do you know when the lands you have mentioned were embanked?—No.

1798. (*Capt. Washington.*) Will you state the slope of the bed of the river between Stirling and Alloa?—11 feet 6 inches.

1799. What is the rise of the tide at Stirling, at Alloa, and at Leith?—Ordinary springs rise about 16½ feet at Leith, 19 feet at Alloa, and 8 feet at Stirling.

1800. (Mr. *Hume.*) Supposing these fords which are now detailed were removed, are you satisfied that the estimate you have now given would completely remove them?—Perfectly satisfied to the extent contemplated.

1801. Are you satisfied, after mature consideration, that the navigation to Stirling would thereby be increased three feet at least in depth?—Yes.

1802. Are there any other means by which the navigation could be further increased beyond the removal of the fords?—The fords could be further removed, and if the barrier at the Cruive were removed the tidal influence would be much increased.

1803. Did you observe the levels above the Cruive Ford, and how far, if it was removed, the tide might flow?—Not particularly, but I have no doubt it might be some miles.

1804. Have you surveyed the Forth from Alloa downwards?—I have seen it frequently, but have not surveyed it.

1804*a*. Have you visited or observed the encroachments made near Kincardine, on Lord Keith's property, whereon an embankment including many hundred acres has been finished, and another is now in progress?—I am quite aware there are such embankments; as to their extent I cannot speak.

1804*b*. Can you, from your knowledge, state what would be the effect if that encroachment which is now going on, on the tide flowing up or down the river, as to the formation of the banks opposite?—I should hardly like to give a decided answer without having visited the spot specially, and taken into consideration the configuration both of the Upper and the Lower parts of the river and Firth.

1804*c*. Then you are not able to say how far these encroachments will impede the flow of the tide upwards?—No.

[*The Witness withdrew.*]

Adjourned till One o'clock on Friday next.

Friday, 6*th June*, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir GORDON BREMER, K.C.B.
Mr. A. CHAPMAN, M. P.
Mr. HUME, M.P.
Captain BEAUFORT, R.N.
Mr. GODSON, M.P.
Captain WASHINGTON, R.N.

Mr. *Wm. Galbraith.*

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Mr. *William Galbraith*, sworn and examined.

1805. (*Chairman.*) You are the town clerk of Stirling?—I am.

1806. A memorial appears to have been presented by the Commissioners of Forth Navigation, stating that the navigation is greatly obstructed between Stirling and Alloa by several fords or shallows of the channel of the river; will you be so good as to explain the object of that memorial and the circumstances attending it, as far as they have come within your own knowledge?—I could not answer that question better than by referring to the Report of Mr. Stevenson, the engineer.

1807. (Mr. *Hume.*) What was the object of your application to the Treasury?—To see if the Treasury would advance money on the security of the rates.

1808. What Act of Parliament have you authorizing you to be conservators?—An Act of Parliament was passed in the year 1843.

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1809. What was the purport of that Act?—Appointing as Commissioners the magistrates and town council of Stirling, with several gentlemen from each of the three adjoining counties, for removing the obstructions to the navigation of the river, and improving the harbour of Stirling.

1810. What authority does that Act give you as to raising money, and expending the money so raised in improvement?—It gives power to the Commissioners to employ engineers and others to dredge the river, to clear away those shallows and fords that are in it, and for that purpose to borrow money on the security of the rates.

1811. What was the amount in 1843 of your revenue?—The amount then and for a number of years prior to that, was 140*l.* a year.

1812. In what way was that money raised?—It was raised by dues levied at the harbour of Stirling on goods and on shipping.

1813. Has that increased?—It is now 350*l.* a year.

1814. What are the several dues you raised that money by?—Tonnage dues on vessels sailing on the river between Alloa and Stirling, and on their cargoes, and on passengers by steam-boats.

1815. What is the nature of the charge?—So much per ton on the vessels, and there is so much per ton on the cargo.

1816. Are the provost and senior magistrate for the time being, of the burgh, members of the Commission?—The whole members of the town council are members of the Commission.

1817. Can you state what was the extent of shipping when you got your Act?—There were twenty vessels belonging to Stirling, besides the half of two passenger steam-boats.

1818. You applied to the Government to obtain money from the Exchequer Bill Commissioners to carry out the repairs?—Yes.

1819. What amount have you applied for?—We have made no special application.

1820. Have you any estimate of what would be necessary to remove the fords which are complained of as an inconvenience to the navigation?—The estimate by our engineer is about 10,000*l.* for the fords, besides the sum necessary for the improvement of the harbour.

1821. Is it your intention to carry out the recommendation of your engineer if you had the means?—Decidedly.

1822. Cannot you borrow that money on the credit of the corporation?—We have not power by the Act to do so, and the corporation of course could not legally do it.

1823. Have you any power by that Act to borrow from other individuals?—Only upon the security of the rates.

1824. Is there any limitation to the amount that the Act authorizes you to borrow?—Yes; until we have expended 5000*l.* we cannot borrow any more than that sum.

1825. How much have you expended since the Act passed?—We have expended scarcely anything on the improvement, because the money we have got has been expended in obtaining the Act. We have made some small repairs of the harbour of Stirling, and improved some roads of access to the harbour.

1826. As the harbour is at the present moment, do you find the town inconvenienced by not admitting vessels to deep water?—Very much.

1827. Can you state what is the largest vessel that can reach the port?—Vessels, I believe, of 150 tons have been known to reach it, but when they do come there they are compelled to wait perhaps till the return of the next spring tide.

1828. What is the trade you expect to carry on if the harbour is deepened?—A great quantity of grain comes to Stirling; there are lime-stones to a very great extent; they are burnt at Stirlingshire and in the neighbourhood for the benefit of the farmers.

1829. To be used as manure for land?—Yes; and there is a great quantity of wool comes; but in many instances the vessels cannot come to the shore of Stirling, and the cargoes are therefore unshipped at Alloa and carted to Stirling.

1830. Have the Commission approved of that Report given in by Mr. Stevenson, the engineer?—The magistrates and town council proceeded upon this when they went to Parliament.

1831. Was that Report drawn up before the Act was obtained?—It was.

1832. Is the Report you have now laid on the table, the Report of the engineer proposing the alteration for which you went to Parliament to obtain power?—Yes.

1833. Since the Act passed, have you been able to carry out any part of that recommendation?—Scarcely any of it.

1834. What is the reason you have not proceeded?—Entirely from the want of funds. We have only succeeded in raising 1,600*l.*

1835. And now you apply to the Treasury for assistance from the Exchequer Bill Commissioners?—Yes.

1836. What security do you offer?—We have nothing but the rates to offer. (*See Appendix*, p. 163.)

1837. Would the town have any objection to become joined as a joint security?—I am afraid in present circumstances they would not agree to it. You observe this 140*l.* a-year went to the general revenue of the town; they abandoned that entirely.

1838. Have the corporation any debts at the present moment?—Yes.

1839. What extent?—About 10,000*l.*

1840. Might the income of the town enable them to pay that debt?—They have just now the customs leviable at the ports, about 1,600*l.* a-year.

1841. Would not the deepening of the harbour, as proposed by the engineer, tend very much to increase those customs and revenue?—I do not think that will increase the customs much; it would increase no doubt the revenue at the shore of Stirling, but I doubt whether it would increase our customs.

1842. Would not these revenues at the harbour benefit the town; and do you think that if

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a public meeting was called the town would not authorize the corporation to become joint security for the money to be advanced by the Government?—I cannot say that they would; I am not prepared to answer that question.

1843. What are the conditions under which you can levy the dues on goods shipped and landed?—We can only levy one-third of the dues until we have expended 5,000*l.*; we can then borrow 4,000*l.* more, and we can only, till that is done, draw two-thirds of the dues.

1844. If 5,000*l.* was advanced towards the harbour, have you the means, from the dues now received, to pay the interest?—Undoubtedly.

1845 After 5,000*l.* expended, would the dues enable you, when increased, to pay interest on the 10,000*l.*, and also a sinking fund of 5 per cent.?—I have no doubt it would.

1846. Do you think there would be any objection to the Admiralty, or the Government, having the power to direct or superintend those improvements, if the money was advanced by them?—Unquestionably not; our object is merely the improvement of the river, and if the Admiralty took it into their own hands it would be satisfactory to us.

1847. Do you think the corporation, and all the present authorities under the Act, would concur willingly in receiving such suggestions, and acting under such orders, as the Admiralty, after due inquiry, might think best calculated to improve the navigation?—I have no hesitation in saying so.

1848. Could you lay before the Board a statement of what the shore dues and income of the Commissioners now is under the limited permission you have to raise; what would be the probable increase after an expenditure of 5,000*l.*, and increasing the dues; what the amount of shipping now is, and what your estimate now is of the increase, provided the navigation is improved by the depth of three feet, as Mr. Stevenson proposes?—Yes. (*See Appendix*, p. 163.)

1849. (Mr. *Chapman.*) Have you tried to obtain the money from any public body, or any Scotch bank?—Yes, we have applied to a number of banks; to the Bank of Scotland and the Royal Bank, among others, and they stated they were in the practice of doing these things, but now they have given it up entirely.

1850. (Mr. *Hume.*) Have you borrowed any money under the Act?—Yes.

1851. How have you expended it?—It has gone altogether in the expense of obtaining the Act of Parliament, including the report and survey of the engineer.

1852. (*Capt. Washington.*) Will you state the rise of tide at Alloa and Stirling?—At Alloa 19 feet, at Stirling 8 feet.

1853. Can you state what size ships come up to Alloa?—Ships of almost any burthen can come up to Alloa.

1854. (Mr. *Hume.*) Do you know under what authority Craig Forth Weir was made across the river?—It was under the authority granted by one of the kings of Scotland; he gave the right of salmon-fishing to the then Lord Elphinstone.

1855. Does that right of salmon-fishing authorize him to dam up the waters, so as to supply the mills with water?—I have never seen the grant, but I know it was so granted. The town of Stirling of the day objected to it, but the thing was overcome.

1856. Where is a copy of that grant to be got?—I have never seen the grant; Mr. Callender, of Craig Forth, is the proprietor.

1857. Is there a mill of any value there?—Yes; it has great power of water; but at certain times of the tide the back water prevents the mill going freely.

1858. Have you observed how high on the weir the tide-water rises?—No.

1859. Is there any document in the archives or records of the town of Stirling respecting the erection of that weir?—There is.

1860. Can you furnish a copy?—I can.

1861. To whom does the wharf belong where the steam-boats load?—The Commissioners.

1862. Have the Commissioners the possession of the harbour of Stirling?—They have; the town council gave it up to them.

1863. And they remain in possession of it for the public?—They do.

[*The Witness withdrew.*]

Mr. *J. M. Rendel.*

Mr. *James Meadows Rendel,* sworn and examined.

1864. (*Chairman.*) You are civil engineer?—I am.

1865. The questions laid on the table were put to you some time ago, I believe?—Yes.

1866. By whom?—Lord Stradbroke. (*See Appendix*, p. 175.)

1867. Were you asked to give an opinion upon this in a general point of view, or were you aware of the particular object in view when they were sent to you?—It occurred at a time when I had just been under a long examination with reference to some improvements contemplated on the Mersey at Liverpool; and the questions there raised were, how far it was beneficial or otherwise to a river like the Mersey to have any large irregularities on its shores, such, for instance, as side creeks embanked, and whether the water which filled those creeks would not, if the embankments were judiciously designed, pass into the higher parts of the estuary. I had prepared myself, by levels and general investigation of the Mersey, to show that the water did not rise to the height at the higher part of the estuary that it rises at Runcorn, and that it was principally owing to those inequalities or irregularities of the shore at the mouth of the estuary which prevented the quantity of water, escaping into those creeks, from passing up into the high part of the estuary, that, in fact, the momentum of the tidal stream was impaired at the mouth of the harbour by the inequalities in the sectional area of the channel arising from those creeks, and that any work which would have the effect of correcting that loss of momentum

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of the water at the mouth of the estuary would have the effect of carrying a larger body of water into its upper portion. The evidence went to that; and the next morning I had from Lord Stradbroke these questions, to which I gave those general answers.

1868. Was the land adjoining the creeks to which you have referred covered at high water?—Yes, to different depths, varying with the tide. I should be very happy to explain to the Commissioners the principle upon which every answer was based.

1869. What tidal rivers and harbours have you examined and reported upon?—Very numerous. I believe there is hardly one in the kingdom of any importance I have not examined.

1870. Have you surveyed Southwold harbour?—I have not.

1871. Have you ever seen that?—I have never been there.

1872. (Mr. *Hume.*) Were those answers given in reference to Southwold harbour?—Certainly not; they were not given with reference to any particular harbour; and I informed Lord Stradbroke, when I put them into his hands, they could only be regarded as answers to abstract questions.

1873. Are you aware they have been considered as applicable to Southwold harbour?—I was not; because some time ago I had a letter from Lord Stradbroke, in which he asked if he might forward those answers of mine to the Treasury with reference to Southwold harbour, and my reply was that inasmuch as I did not know the harbour, and they were general questions, that it must be so stated if he forwarded them.

1874. You could not say whether they applied or not?—Yes; I gave Lord Stradbroke clearly to understand that they were to be regarded as general answers.

1875. In the course of your experience, have you been enabled to lay down any principle that would be generally applicable to the improvement of tidal harbours?—I have not; I find it necessary, in my experience, to treat every case according to its own peculiarities.

1876. Are the Commission to understand that the answers given to those general questions submitted to you by Lord Stradbroke could not be applicable to Southwold, or any other river, unless you had previously examined such river?—Clearly so. Indeed, I consider almost all those answers as emanating from the examinations which I had given a day or two before in the particular case that I have referred to. The great object of embanking a river should be to improve the course of its channel in such a manner that a smaller quantity of water should perform more useful effect than any larger quantity of water due to its natural shape could perform.

1877. Do you mean by narrowing and straightening the course?—Yes; and I will explain generally the view I have on a subject of this sort. If I could find two rivers precisely alike, I should then say that the improvement of those two rivers ought to be attempted precisely in the same way; but I have never yet found two rivers precisely alike. I will take this case of Southwold. Here I see there is a bar, and the whole coast encumbered with sands, and there are some antagonist principles at work. It is very clear that the consideration of an engineer would be first of all directed, if this harbour was to be improved, to what was best for the maintenance of an entrance. He would never think of looking at what was best for the navigation up the river until he had determined how far that plan, which he might otherwise propose for the improvement of the higher part of the river, agreed with what was necessary for the improvement of the entrance, because, supposing we could get 18 feet of water in the interior channels, if we did not at the same time maintain a good entrance, as far as the harbour was concerned the whole thing would become useless. I should say, in a case of this sort, the first thing to be considered would be how far any works which might diminish the area of the interior space would affect the maintenance of a given depth of water over the bar, because this is one of the cases which will always have a bar, and you cannot have it without a bar.

1878. You mean diminishing the flow?—Diminishing the quantity of water, because here unquestionably the good or bad state of the bar depends in great measure on the quantity of water passing to and from the estuary; therefore anything that diminishes the quantity of water (beyond that which is expedient to prevent a strength of current through the entrance inconvenient to navigation, which would be as bad for the harbour as a bar,) would unquestionably have a tendency to increase the bar, because it could only be kept in subjection by a considerable ebb current from the harbour. I should say that Southwold Harbour is one of the numerous class in this country that must be satisfied with having a good basin immediately within its piers, because I am quite satisfied, as a practical question, there is no hope of doing anything for the improvement of the upper navigable channels of such a harbour as this. There is not sufficient quantity of tidal or fresh water to enable you to effect it. This harbour or estuary must be looked at simply as a great reservoir, in which a quantity of water should be retained to keep in subjection the bar. If it were a matter of vital importance to the country that vessels of the class I was trying to accommodate within the harbour, should go a long way up into its interior, I should treat that harbour in a different manner. I should define one channel for the tide and fresh water stream, and contract it in such a manner that it should be able to maintain that particular channel to the required depth. Hence, then, I should be prepared to sacrifice some of the advantages which I was before anxious to obtain from a large body of water for securing the bar. The most perfect arrangement for a case of that sort that could be effected, if we had an unlimited amount of money, would be this,—to make a new straight and deep channel, which should contain the same quantity of water as this shallow and irregular harbour; but, commercially speaking, this is unattainable in all these little harbours. As I said before, there are many harbours where the stream is so great at the piers that it amounts really to a greater objection than the bar itself, and consequently there it is very desirable to lessen the stream.

1879. (*Capt. Beaufort.*) Will you mention one or two of those harbours?—The case that strikes me at the present moment most forcibly is Berwick. There the stream is frequently so

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great that it amounts to a greater danger than the bar; for if a vessel misses the pier heads the least in the world in beating in, and falls off, the stream carries her beyond the pier, she loses her way, and is drifted on a lee-shore, and consequently there the stream is the greatest impediment of the two.

1880. (Mr. *Hume.*) Then the bar is not in the way in that case?—The bar is a little further out, and there is a sand-bank, which amounts to a dangerous lee-shore between the bar and the pier.

1881. (*Chairman.*) What are the chief obstructions in the propagation of the tide that are usually found to exist?—The inequalities in the bed and shores of the river. I have always found in rivers of this sort that there is a great probability that the tide will be higher at the entrance than at the upper parts of the harbour. That arises frequently from two causes. We find it a practice with engineers, in order to have such a rapidity of current through the entrance piers as will drive away what is ordinarily called a bar, to contract the entrance so much that the tide has not time to fill the basin within. Now when that is the case it is manifestly an injurious contraction, because you are defeating the very end you have in view, viz., getting the largest quantity of water within the piers; and it is of great importance also that you should have as much water as possible in the higher parts of the harbour, because it will be very clear that the water which flows into this part is not only the last to ebb out, and, therefore, having the greater fall, produces a greater effect on the whole of the channel, but also performs its effect on the whole course of the channel; consequently it is very important to have the harbour in such a form that there shall be a higher tidal flow at the inner extremity than at the sea end. The Mersey is a case of this sort. The tide rises at Runcorn, which is about 20 miles from its mouth, from 18 to 20 inches higher than at Liverpool; but between Runcorn and the head of the estuary it falls, that is, there is a contraction at Runcorn which prevents the tidal wave from being propagated as fast above that narrow as below. It is very plain that anything that would take away that obstruction, anything that would enlarge that stricture in the river, and let the water up into the higher part of the estuary, would be a positive improvement. If in a river of this sort the entrance is so contracted that the water is throttled, it is manifest you are losing more than you are gaining by the increased stream. I should also say that I have, in all cases, a very great objection to a stronger stream than is absolutely necessary for the removal of the bar, for it creates that amount of disturbance which irritates the bed of the river unnecessarily, and is the cause of evils as great as the bar itself.

1882. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down by freshes or tidal water?—That again does not admit of a general answer. In many rivers I believe the navigable channels owe principally their existence to the fresh water; in many others they do not. A case came the other day under my notice; that is, Belfast. I was of opinion that the slobs or mud banks on either side of the Lough of Belfast might be advantageously embanked, because I anticipated that the quantity of tidal water passing up beyond the proposed embankment, upon its return, aided by the river water, would maintain a channel, well defined by properly protected banks very much more efficiently than the channel could be maintained whilst unembanked. Now there is this very great advantage gained in a case of that sort. It is a fact well known to me, from my connexion with Lynn, that in the winter season, when one might expect from the quantity of sediment brought down by the Ouse the harbour would be in the worst state, it is always in the best state. This arises entirely from the harbour being more occupied by shipping in the winter than in the summer, when the extra scour produced by the partial obstruction of the shipping in the harbour tends to keep that harbour in good condition; and I have remarked it in many other cases. In navigable channels much frequented, particularly if by steamers, you get the channel into a better state than if it has no navigation. The conviction in my mind is, therefore, that in a case such as this of the Belfast Lough, where there are no injurious sand-banks at the entrance (for it is a long and deep funnel-mouthed bay, instead of an ordinary estuary), there would be no injury arising from the embankment of those slobs; but if one commits one's self to that as a principle, one would get into all sorts of difficulties.

1883. (Mr. *Hume.*) Might you not, as a general answer, say, that in all navigable rivers to enclose slobs or mud banks, so as to exclude the tidal wave would be injurious?—I should rather put it in this way, that in all estuaries encumbered at their entrances by sands, liable to great fluctuation from prevalence of winds, nothing that tended to lessen the quantity of water going into the harbour ought to be permitted; but if an embankment would have the effect of increasing the quantity of water going into the harbour, then, I say, it ought to be encouraged. It is a question of degree in all cases. It is too much now the practice to imagine that an embankment necessarily implies a diminished quantity of water in the harbour. It does no such thing.

1884. If you narrow the sides, and do not deepen the bottom, must you not lessen the volume to pass?—It by no means follows, as I know from experience, that cutting off a creek at the mouth of a harbour lessens the quantity of water flowing in.

1885. Are not the two creeks on each side, which you have cut off, filled with tide, and do they empty with the ebb; and, consequently, being shut out by these embankments, would not the outer scour be lessened?—No. Supposing it is found by levelling that a tide which rises at the entrance, say 20 feet, does not flow as high at this point as at that by two feet, which is frequently the case. We know perfectly well from our experiments upon a discharge of water through pipes that these two creeks act as bulbs, and distort the current flowing into the estuary in such a manner as to lessen its general momentum; hence it is, that if you cut off these creeks you do not lessen the quantity of water. The flow of tide at the mouth remains the same precisely, the basin is not full, and the water which filled these creeks will pass into the upper portion of the harbour.

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1886. Are the Commission to understand that while you shut out a million gallons of water which filled these two creeks, the increase of the current will raise the level in the upper part, so as to admit more water than the million gallons which you have excluded?—I do not think it will admit more. If a harbour is not full, for instance, if the tide retreats from the entrance before the wave has been propagated to its full level at the extremity, it is manifest that the harbour is not full. If the harbour is not full, it is an evidence of one of two things, either that the entrance is not large enough for it, or that the current is so interfered with by sand-banks and irregularity of shores as to prevent the momentum of the wave accomplishing its full purpose.

1887. Are the Commission to understand that the existence of those two creeks act in a certain manner as if they were impediments to the general current?—I think they do; practically there is no such thing as an estuary of this form without banks and shoals. The banks and shoals are more or less occasioned by these creeks. I have hardly ever seen a deflection of current into these creeks that is not followed by a bank; and these creeks are the cause of many banks which reflect back the evil I have been referring to, that is really the case practically.

1888. Can you lay down any rule which would sanction the cutting off side outlets in estuaries or rivers, such as you point out?—No.

1889. Until you have examined the level of the water at any given point between which you wish to make the clearance, you cannot form an opinion what measures should be adopted?—You cannot.

1890. Are the Commission to understand you to give a decided opinion that before any creek, reserving tidal waters, should be shut up, you ought to ascertain the difference of level between the bar and the upper part of the harbour which you wish to fill?—The whole engineering condition of the harbour ought to be minutely investigated before any engineering works ought to be permitted.

1891. Having ascertained all the facts you have pointed out as necessary, is the object to be obtained; the admission of a greater volume of water into the harbour?—It is. In cases of this kind we are assuming that it is necessary to the condition of the harbour's mouth that the greatest possible volume of tidal water should pass in and out; we assume that as the state of the harbour which we are now going to speak of. Then, I say, the first business of the engineer would be to ascertain by levelling, and the fixture of proper tide guages at different parts of the harbour, the exact state of the tidal flow at springs and neaps, that is, to compare the flow of the tide at different parts of the harbour. If he finds that the higher part of the harbour is not filled to the same level as the lower part of the harbour, his business should be to design such works as would accelerate the tidal wave into the higher part of the harbour.

1892. If you were informed that in the River Tay by dredging, removing fords, and other obstacles, the tidal wave had been hastened in its approach to Perth by 50 minutes, would you from that conclude that the operation had been beneficially employed for navigation?—I should, but with this qualification, that it is perfectly practicable to accelerate the tidal wave, and yet to reduce the quantity of water in the harbour. I should say, that if the tide is accelerated in time and height, it is accelerated beneficially for the harbour, provided you have not reduced the quantity of water so as to affect injuriously the harbour's mouth.

1893. Does your answer imply that you narrowed and deepened, you did not diminish the volume?—Clearly.

1894. So as to maintain the same scour, but in a better direction?—Clearly; because in the one case it is benefiting the upper part of the harbour to the injury of the lower part, or the bar.

1895. Can you apply that generally to harbours, such as Southwold, where portions of the land on each side of the centre stream are covered with water?—I would apply it to all cases where harbours have at their entrances threatening sand-banks. These are subjects which involve so many considerations that I hope the Commission will not fancy I am fencing with any question; but it is really necessary to draw very minute distinctions; for instance, I will assume that one could afford to lose a certain portion of tidal water in Southwold harbour; I mean with reference to any damage that might arise from that loss at the bar. Then to benefit a town at the head of such an estuary, it would be justifiable in an engineer to accomplish the improvement of the higher part of the harbour, and to lose such a quantity of tidal water from the scour of the bar. It is a nice discrimination of all minute differences which constitutes the value of an opinion in cases of this kind.

1896. Then it appears from your opinion that the harbour may be injured by the mouth being too narrow, as well as by being too wide?—Frequently more.

1897. Is it a rule that the mouth should be of such width as to admit to the extremity of the harbour the tide, to the same level, by the time the tide turns at the mouth?—It is. If, however, I want to employ a very rapid current at the harbour's mouth, it may be justifiable to so contract it as to lose a portion of the water flowing into the upper part of the harbour; but that must depend entirely on the circumstances in which the engineer is placed, and the object which he has to attain. Hence it is one of those complex questions which can only be answered by reference to a particular case.

1898. Do not changes often take place in harbours where freshes and strong tides are admitted, so as to require constant watching and attendance on the part of some superintending engineer or surveyor?—Most decidedly.

1899. From your experience of harbours, are you able to state whether more of them have been injured by neglect than have been injured by injudicious application of improvements?—I believe many more have been injured by injudicious applications of what were considered improvements, than by natural decay.

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1900. Has your experience pointed out that local interests often interfere with the general interests of navigation?—Most destructively so.

1901. Is it then your opinion that every harbour should be placed under the superintendence of Government, unconnected with local interest, and directed solely to the general advantage of the nation, so that their improvements might be directed to general advantage, instead of local purposes?—If I thought that the Government could command properly qualified persons for the purpose of directing and controlling all these harbour improvements, I should say so; but unless men of competent ability and skill are called upon to control these works, I believe greater evil would arise from ignorance than from cupidity.

1902. The question is put to you under the belief that if the Government, the Admiralty, for example, had power deposited with them, and charge entrusted to them of all the estuaries and harbours of the country, that they would employ the most talented men the country could afford?—I have ever thought that the Admiralty is the proper Board to have the conservancy of the harbours of this kingdom; and although it throws upon the Admiralty a vast amount of additional labour, I am quite satisfied that any minor Board would want the influence which the Admiralty can exercise to overcome local influences, and that the present practice of referring particular cases, as they arise, to men of eminence, unconnected with the particular work, is the safest course the Government can adopt. In these days professional men who have acquired the eminence which could justify a public Board in deferring to their opinion, are so much employed, that the Government would not be able to monopolize their time. I cannot therefore but think, under all the circumstances, that the practice at present resorted to, of the Admiralty referring questions to five or six engineers, whom the country may consider as best qualified to give an opinion when called upon to do so, in any particular case, is the one after all that will give the greatest amount of satisfaction; and I think it is very manifest, from the way we see the Railway Department of the Board of Trade treated, that any minor Board would not be useful; in fact, the Admiralty would still be applied to, with, perhaps, the disadvantage of an opinion previously expressed by another Board.

1903. Your opinion is, that the influences likely to affect local improvements in the different harbours and ports of the country is so great that the Admiralty, being the most powerful, and entrusted with the most important interest, ought to be the party to have the check, and control, and direction?—That is my deliberate opinion.

1904. Have you considered in what way that check and control could be entrusted to that body, charged with other important business at the same time, and carried out?—The impression on my mind is, that it is necessary that a Board of this sort should have the full stamp of Government authority; and I doubt very much whether any Board in this country could have that strong impress, which is necessary for its usefulness, that had not all the disadvantages of a political Board.

1905. Are the Commission to understand that a supervising authority over ports and harbours of this country should vest in that body having the greatest political and official power in the administration?—I think so.

1906. With a view of having at all times information before the Admiralty, do you consider that that Board ought to have in their possession maps, surveys, and all the requisite information of every such port and creek in the country?—I think they ought; for I have found that the greatest inconvenience and difficulty, which engineers meet with in treating questions of this kind, is the absence of anything like a correct plan without putting the parties who call for his opinion to the enormous expense of these surveys. I think it is most material to the preservation of the public harbours of this nation that there should be at once made accurate plans, comprising the full extent to which the tide flows.

1907. (Capt. *Beaufort.*) Such as the Irish Ordnance Survey?—Yes; the most detailed surveys. It is only recently that the Admiralty Surveys have been worth anything, as far as harbours are concerned. It is only very lately that the Admiralty surveyors have given that minute attention to the peculiarities of an estuary which the engineer requires when he comes to consider its improvement.

1908. (Mr. *Hume.*) Have you considered whether, if an annual report of the changes, whether by improvements or by natural causes, that may have taken place in every harbour should be made to the Admiralty, that would be the means of preventing evil and promoting improvement?—I think in all cases where Acts of Parliament confer power of local conservancy upon corporations, that those corporations should be required, having been furnished with the first public plan of their harbour, to record upon it, from time to time, through the medium of the Admiralty, any changes that had taken place. There is nothing that would help the engineer so much as to know the history of the harbour that he is called upon to improve.

1909. Do you consider that it would be requisite to have an engineer officer appointed, whose duty should be to watch over and attend to the harbours in a given district of the coast, so that he would be prepared to report any change that was taking place?—I do not think it would be in the power of any individual to take such duties upon himself. I should prefer to have a Parliamentary compulsion upon parties to make these annual reports, than that there should be any officer appointed for that purpose. I do not think it would be in the power of any individual to record those changes which I am assuming ought to be recorded by the harbour-master, where there is one, or by the resident engineer, because it is a very difficult thing for a man who only makes occasional visits to a harbour to mark off those minute differences, material to the history of the harbour, which can only be correctly represented on the plan by repeating a part of the process of the original survey. In such surveys of harbours as I am now referring to, bench marks, permanently fixed along the shore, as a means of determining if any change has taken place in the level of its bed, are necessary. I doubt very much if this could be done by a *visiting* engineer.

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1910. The question alluded to this, not that he should do it, but whether the officer having charge of all the harbours from the Thames mouth to the Frith of Forth could not visit places, examine the report made by the resident engineer, and so far be able, when called upon, to give information to the Admiralty on each of these points?—I think it would be ill attended to, and would prefer the reports of the local engineers than get them modified by the views and opinions of the superintending engineer.

1911. (Capt. *Beaufort.*) In that case would it not be necessary that that history of the port should, from time to time, be put in by a competent engineer?—If the harbour-master was a competent man, he would be sufficient.

1912. (Mr. *Hume.*) All your experience leads you to the opinion that the ultimate check and control over all works connected with harbours should rest with the Admiralty?—I think so; and I confess that, as far as I have seen, their decisions have been judicious, and there has been a proper amount of firmness in their maintenance.

1913. Are you aware that they seldom interfere, unless applied to?—I was not aware of that. If that is the case, I think it ought to be an indictable offence to interfere with any estuary without a previous communication with the Admiralty.

1914. Is it your opinion that every alteration in the tidal waters of this country, or navigable rivers, should be reported to and decided upon by the Admiralty, before it is undertaken and carried out?—I think it ought to be an indictable offence to interfere with the flow of the tide in the estuaries or harbours of this country, without a plan being previously submitted to the Admiralty and approved.

1915. Is it not equally necessary that all bridges crossing navigable channels, railroads, or other works interfering, should equally be reported, and under their direction?—Most unquestionably, all interference, whether from bridges across the stream, altering the stream, or any act involving a change should be submitted to the controlling Board, which should be the highest connected with the subject which the country affords, namely, the Admiralty.

1916. From your experience, can you state generally or point out any particular instance where alterations which have been made have injured harbours?—I know many cases where great injury has been inflicted upon harbours by works even authorized by Parliament.

1917. Under that impression, ought not every Act of Parliament interfering in any way, or giving power in any way to interfere, with the harbours of this country, to be passed under the direction and not without the sanction of the Admiralty?—Certainly; there ought to be no work permitted to be introduced to Parliament until it had gone through that ordeal with the Admiralty which it is obliged to go through with the Standing Order Committee.

1918. If your experience points out much injury to the harbours of this country from acts of commission, whether under Act of Parliament or otherwise, does your experience point out any instances where, through negligence or want of attention, harbours have been injured?—In many harbours that I have examined; and I have found acts of encroachment of a most dangerous kind from their being silently performed, and it is on that account specially that I should strongly urge the propriety of having harbours mapped out, and the limits of the tide laid down upon them. I know instances where landowners have, from a knowledge that they were doing wrong, made first of all a wicker embankment, then progressively a stone embankment, and ultimately shut out the tide altogether. In fact, that kind of insidious encroachment which escaped nine out of ten of ordinary observers is the kind of thing from which harbours in this country have suffered as much as anything, and I think more than from open acts.

1919. Those parties being generally the lords of the manor or parties interested in the adjoining land?—Clearly.

1920. If the conservancy under the Admiralty, to which allusion has been made, were properly constituted, and which you think ought to be constituted, such evils in future would be prevented?—They would; and I think it would not be amiss for the Admiralty, if a public Act was passed for the purpose, to have something like a veto in the appointment of the persons locally charged with the preservation of the harbour.

1921. With the view stated by you, in every commission appointed by Act of Parliament, or under any charter granted by the Crown, or under the power any corporation holds, should not the Admiralty have the power of naming a certain portion of the Board who are to have charge or carry out improvements or alterations in the river?—I have always thought so, and in several cases have reported to that effect. I think it would be a wholesome check to what goes wrong now in local management.

1922. Is the opinion you have now given of the injuries caused on the navigation of this country by lords of manors and proprietors of lands adjoining, who by their silent and gradual encroachments have done the injury, founded on your own actual experience as a surveyor?—They have come under my own particular observation.

1923. But which, from delicacy to the parties, you would rather not detail?—I conceive it would be inconsistent with my professional capacity to do so.

1924. But of the real injury done to the national harbours, and of the injury in progress, you are perfectly satisfied?—Perfectly.

1925. And the opinion as to the altered law and surveillance recommended is with the view of promoting the public good?—Entirely.

1926. (*Chairman.*) You were employed by the Admiralty to report on an embankment made by Sir James Carnegie in the harbour of Montrose?—I was.

1927. Did you make any report?—I did.

1928. Is the report laid on the table a copy of that which you sent to the Admiralty?—Yes.

1929. Will you state the substance of that report?—The substance of the report was this,

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that the encroachments had been made to an injurious extent; that as the encroachments had gone so far it would be better to compensate for them by improving the channel of the river that had been left than to remove the embankments and allow the tide to flow over the space as before, on this principle, that unquestionably the river, by running at the foot of high earthy cliffs, had encroached so much on the shore that unless an expensive embankment was made it would carry into the lower part of the harbour large quantities of soil as it fell from the cliffs; that if the embankment was removed, and things restored to their original position, then it would be desirable, as far as the harbour was concerned, to make a stone embankment along this shore, and that there were no parties prepared to do that. Then I thought it a judicious compromise, under all the circumstances, to let Sir James Carnegie have his encroachments, on condition that he would give us an excavation along the line of the new channel, and do certain other things which I recommended in my report.

1930. (Mr. *Hume.*) Your opinion given to the Admiralty was, that the encroachment was injurious, unless compensation were made by opening an equivalent channel?—Yes.

1931. If that was done, you consider that the enclosure might remain?—It might.

1932. But not otherwise?—Not otherwise; and he has resisted that.

1933. Did you go round the basin at Montrose, and observe whether any other encroachments had been made on any other part of the banks at other times?—I did. I observed that very considerable encroachments had been previously made, and that Sir James Carnegie was only following the bad example that was set him. Montrose is one of those cases which points out the absolute necessity, if you are going to preserve the harbours, that there should be a good engineering map made of them.

1934. Are the Commission to understand that that engineering map should be made under proper authority, and then lodged in the Central Office, under the Admiralty, in order that they may at any time detect any encroachment?—Decidedly so, as a public document for public reference.

1935. Does your report state the amount of gallons or cubical feet of water excluded by that enclosure?—Ten millions and a half of cubic feet at ordinary spring tide.

1936. Did you observe of what extent the other encroachments were?—They have been very extensive on that estuary. The whole of the upper part of the estuary has, more or less, been embanked.

1937. Although the harbour trustees of Montrose have, by Act of Parliament, the superintendence and power to regulate and manage the harbour and basin, is it your opinion that the Admiralty should have the charge over them in that harbour as well as in all others where the navigation is affected?—Certainly; I think it should be general; I think it should apply to all harbours.

[*The Witness withdrew.*]

Adjourned till Wednesday next, at 1 o'clock.

Wednesday, 11th June, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir Gordon Bremer, K.C.B.	M. A. Chapman, M.P.
Mr. Hume, M.P.	Captain Beaufort, R.N.
Mr. Rice, M.P.	Captain Washington, R.N.

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Mr. *Henry Cleaver Chapman* sworn and examined.

1938. (*Chairman.*) What is your profession and place of residence?—I am a merchant and ship-owner at Liverpool.

1939. Have you been at sea and in the habit of trading to Liverpool?—Not to Liverpool, but to London formerly; but I have been resident at Liverpool for fifteen years as a ship-owner.

1940. How long have you been at sea?—I was at sea about twelve years.

1941. (Mr. *Hume.*) Are you now a member of the Dock Board at Liverpool?—No; I have been, but I resigned.

1942. How long were you a member of that Board?—Two years.

1943. Had you an opportunity of attending to the state of the navigation which is under the management of that Board?—Constantly; it came before the Board on every Board day.

1944 Were you at Liverpool when the discovery of the Victoria Channel by Captain Denham took place?—I was.

1945. What was then the state of the harbour before, and what has been the result of that discovery?—It is no new discovery; it has been there from time immemorial; it will be found in an old Admiralty Chart of Greenvile Collins, of 1688. It was published when William III. embarked at Hoylake, which is close to Liverpool. At that time the ships used to lie there and discharge their cargoes, and come up the inner channel when they had lightened; but he remarks upon that Chart, there is a channel called the Formby Channel, with three fathom water, but not being buoyed off is not known; and that remained down to the time Captain Denham came.

1946. Are the Commission to understand that until Captain Denham surveyed the whole estuary, that channel which was known a century ago, and recorded, as you state, on an old map had not been used by the trade of Liverpool?—Occasionally steam-boats and fishermen

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who knew it well, would run across; but the pilots always set their faces against it, and would merely call it, by way of getting it into disrepute, the Swashway.

1947. How has it been buoyed?—After a great deal of importunity, the Dock Committee at last allowed Captain Denham to carry out his plans; but they thwarted him in almost every possible way, grumbling at the expense, and thinking it all useless; that the old channel had done very well before, and they could go on in the same way. At last he succeeded, and when they found the channel of such infinite service they were obliged, in deference to public opinion, to complete it with a lighthouse and light ships.

1948. Was Captain Denham employed to survey under the hydrographer?—Yes; previously to being engaged by the Dock Committee.

1949. And it was upon his suggestion and urgency that the Dock Committee allowed the buoys to be placed in that channel?—It was.

1950. What has been the effect on the navigation since that period as to the facility of entrance or exit?—It has, in point of fact, made Liverpool the port it is. We have a good passage in or out with the aid of steam, and nothing could be better.

1951. Can the harbour now be taken in the night, in consequence of the arrangements that have been made with ease, whereas formerly it could not?—Formerly it could not at all be taken by a sailing-vessel, but now with that new channel and a leading wind, I would as soon take a line-of-battle ship in there in the night as in the day.

1952. With perfect confidence?—Yes.

1953. Did Captain Denham make a proper survey of the estuary?—Yes.

1954. Was it in the course of that survey that he discovered this channel?—He discovered the utility that this channel could be made to the port.

1955. Are you aware whether any report had been made to the Admiralty by any preceding individual of the possibility of making that channel useful for navigation, as it has now been made?—I am not aware that any had gone up from Liverpool until Captain Denham made his report.

1956. If the Admiralty had ordered a survey, or had had a proper chart of the estuary of the Mersey years ago, do you consider that that passage would have remained in the state of neglect in which it has remained?—Certainly not.

1957. You stated your anxiety to see all the lighthouses of the country under the superintendence of some central board. Have you directed your attention to what would be the benefit to be derived if the harbours generally were so placed as that the Admiralty should have a knowledge of every harbour, creek, and estuary, by survey, so as to be aware of any change, either of improvement or from neglect that may take place?—The benefit would be almost incalculable, because you cannot expect to find in small outports scientific knowledge, or that with knowledge, you can get men, if it affects their private interests, to take a national view of the question. I assert that although a few individuals may be benefited very often, yet great national injustice and injury is done.

1958. Are the Commission to understand you to state that the estuary of the Mersey should be considered as a national harbour, and consequently that, although local Commissioners might conduct the business of the harbours, yet that there ought to be a superintending care to protect the harbour for the nation?—Yes; Government taking advantage of the Liverpool Dock Trustees, when they went to Parliament, and were squabbling amongst themselves, did appoint a conservator for the river Mersey, but they omitted to give him jurisdiction over the river Dee also. The works of the docks in Liverpool have completely silted up the Rock Channel; and in consequence of encroachments I have always understood that the river Dee, up to Chester, is not navigable for vessels of any size.

1959. When was the conservator appointed in Liverpool?—Three years ago.

1960. Who is the officer?—Captain Evans, of the Royal Navy.

1961. Has that appointment given satisfaction to the commercial interests at Liverpool?—Very much so.

1962. Are the Commission to understand that the tidal water from the Mersey has in some degree interfered with the navigation of the Dee, and that you think there ought to be a superintendence, not only over one, but over both?—Over both. I think the one who has superintendence at Liverpool ought to have jurisdiction over the Dee also.

1963. Are the Commission to understand that you mean there ought to be a general superintendence over harbours along the coast, of some authority, in order while you are improving one part to prevent injury to another?—I think they ought generally to be appointed, and I more particularly mention Liverpool and the Dee, being able to speak of the local advantages which would occur there. The inference is, that that would take place throughout the country.

1964. Do you think the same surveillance or superintending power which you consider would do good to the Dee and the Mersey, would equally apply to every other part of the country?—Yes.

1965. Has that been a question of conversation with the ship owners and mercantile men of your acquaintance?—Not so much so in Liverpool, because, as far as the lighting and buoyage goes, it is very complete under Lieutenant Lord, R.N., and Mr. Jones, R.N., his assistant.

1966. It being now complete, does not alter your opinion of the necessity of a general superintending power, to take care that no mischief in future arises?—No.

1967. Were you at Liverpool before 1839?—Yes; I went to Liverpool in 1830.

1968. Between 1830 and 1839, what was the state of the navigation there regarding lights and management?—It was very bad indeed, and constant losses were taking place. Even a buoy was grudged if it was wanted to be put down to make the thing perfect.

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1969. From what period did the improvement take place?—From the time Captain Denham was appointed.

1970. Then you consider Captain Denham's recommendations and assistance there to have been highly useful to change a bad into a good system?—Undoubtedly.

1971. In speaking of the superintendence, do you consider that it would tend to the general improvement of the harbours in this country if the Government were possessed of an accurate survey of every creek, port, and harbour navigable, to which reference might be had as to the present state, and consequently for reference in case of any future alteration?—The greatest possible advantage to the country; and the great wonder is, that it has not been looked into before.

1972. You think that it would meet the approbation of the merchants and ship-owners generally?—I am quite satisfied about it; and if there was any difficulty about the expense, we should be happy to pay a tonnage duty.

1973. You consider the preservation of the harbour, from negligent management, of so much importance, that even if expense was an objection, you would not object to a moderate charge for that purpose?—Not at all.

1974. (Mr. *Rice.*) Are you of opinion that the navigation of the Mersey and the security of it was very much benefited by that Conservancy Bill?—I think so.

1975. From your experience during your residence at Liverpool, is it your opinion that local management often has interfered with what ought to be national objects?—Undoubtedly; I do not think any person in Liverpool will attempt to say to the contrary.

1976. Is it your opinion that that sentiment is generally entertained by the ship-owners and merchants?—It is; and I am now deputed by the ship-owners to appear for them. I can speak their sentiments. We were just on the point of memorializing Government to put the Liverpool Docks under a Government commission, so badly do we conceive the thing has been managed, they are in reality national harbours under local trustees.

1977. Was that conversation to which you allude at the Committee of a Ship-owners' Society?—It was.

1978. And you have been deputed by that society to come to London to represent the state of the lighthouses and the navigation there?—Yes.

1979. Do you think that any Board should have the power of interfering with the navigation of this country, without the previous sanction and authority of a central Board, such as the Admiralty?—No, I think the central Board would then be held responsible; there would not be local interests to bias them in any way, their object would be the national good.

1980. You are convinced that great benefit has arisen from the appointment of a conservancy of the River Mersey?—Yes, we have now some security.

1981. Do you from that benefit consider that the same good would result if that was carried through every port and creek in the country?—Decidedly.

1982. (*Capt. Beaufort.*) Under whose care are all the lights and buoys, and ships, and everything connected with Liverpool?—The Dock Committee.

1983. How are the Dock Committee elected?—Thirteen of them are sent from the Common Council, and eight elected by the Dock rate-payers.

1984. Have commercial or maritime interest any voice in electing those?—Out of the 21 members, 13 are sent by the Common Council and eight are elected by the Dock rate-payers.

1985. Was it usual to have any seamen among those trustees?—They have had some.

1986. Was it of necessity to have a certain number of maritime people among the Dock Trustees?—Not at all.

1987. (Mr. *Hume.*) There being a sailor or not appointed to that Commission depended on their being members of the Town Council?—Yes, formerly.

1988. Do not the 13 deputed depend on the political opinions of the majority of that Council?—Entirely.

1989. Consequently the real interests of the harbour in selecting the best qualified sailors and the most scientific men formed no part of the ground of selection?—Not at all.

1990. Does the same political bias actuate or aid in the appointment of the eight Dock rate-payers?—Always, political management has been the curse of the Dock estate.

1991. In the evidence you have given, are the Commission to understand that you would wish to see the navigation of the Mersey conducted by persons selected according to their ability, and not by political party?—Entirely so, but this can only be done by altering the constitution of the trust.

1992. (*Capt. Washington.*) Have you ever sailed a ship through the Victoria Channel?—I have been with steam-boats and yachts in and out frequently.

1993. (Mr. *Hume.*) Have you any suggestions to offer with respect to the improvement of the navigation of the Mersey, or any other harbour?—Nothing, except having a superintendence over the harbour. The Mersey being a very rapid and deep river, must, more or less, affect all the tidal places adjacent. Also, if I may express my opinion, I think that Government should embrace the opportunity of altering the constitution of the Liverpool Dock Trust when the Trustees again apply to Parliament for a new Act. The rate-payers should be convened annually, and the trustees compelled to render an account of their stewardship, and the ship-owners and merchants allowed an opportunity of stating their complaints.

[*The Witness withdrew.*]

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Mr. *Charles Hicks*,
Mr. *David Manser*, Clerk to the Rye Harbour Trust, and } Sworn and examined.
Mr. *Henry Stocks*, Rye Harbour-master,

[*Mr. W. Cubitt's large plan of Rye, on the scale of* 61 *inches to a nautic mile, made by Messrs. Sherrard and Hall, engineering surveyors, in October*, 1839, *with numerous sections, was exhibited.*]

1994. *Chairman.* (To Mr. *Hicks.*) Are you the chairman of the Rye Harbour Trust, and reside at Rye?—Yes.

1995. How long have you been acquainted with the harbour?—30 years.

1996. Did you sign the memorials of the 22nd of May to the Admiralty?—I did.

1997. What is the present state of the harbour with respect to navigation?—Very bad; it has been better probably than it is now.

1998. Will you state briefly the former state of the harbour?—In the year 1813 or 1814 it was very much worse than it is now, and there was a good deal done to it then by erecting jetties on the westward. There are opinions as to the advantage of either western or eastern groins. Our harbour cannot be kept open without groins from one side or the other; and I hold in my hand two reports by Mr. Cubitt, one dated the 29th of July, and the other dated 17th of April, 1839. In his first report he speaks of the jetty which then stood at the western entrance, and states that the last length of the western groin he desired to be completed, and that the deepening of the channel appears to have been judiciously begun. That report was laid before the Commissioners of Rye Harbour, but they did not concur in it. He came down again in 1839. During this time the majority was against the views he had taken, and they built the eastern groin which is now standing.

1999. (*Capt. Washington.*) The Commission would not receive the report, because they did not approve of it?—They would not.

2000. (Mr. *Hume.*) Did the Commission take any other advice?—No.

2001. They acted on their own judgment?—Yes; he was sent for again in 1839, and he made another report, and he recommended the eastern groin to be also continued, because they had been at so great an expense.

2002. Between the report of 1833 and 1839, had the Commissioners erected the eastern groin which he now recommends to be extended?—Yes.

2003. (*Chairman.*) Under whose direction was the eastern groin erected?—The Commissioners of Rye Harbour.

2004. Against your opinion?—Yes.

2005. (Mr. *Rice.*) Not subject to the report of an engineer?—No.

2006. Was it subject to the opinion of the harbour-master?—No, I think not; it was voted at the Board on the view of a certain number of Commissioners. There has been a western groin and an eastern groin, and then there was an eastern groin, and then a western groin, according to the majority of people sitting as Commissioners.

2007. (Mr. *Hume*). If there had been a power in the Admiralty, or any superintending power to have decided, it would have prevented that from taking place?—Yes.

2008. Would that have been consistent with your wish and the opinion of the Commission generally?—I stated at the Commission that I should cease to take an active part till there was some authority to go by, and that I wished the Government would direct what was to be done, because I have seen the effects of it on the harbour of Newhaven, where they act under a consulting engineer every six months; and that harbour within my time has been very much improved; but where it is subject to the vote of a variety of Commissioners, one party often counteracts that which the other has done.

2009. Then, your opinion is that the harbour would have been better if there had been one system adopted and judiciously carried on under a superintending power to check these changes?—Yes.

2010. (*Mr. Rice.*) What is the number of Commissioners altogether?—Forty-eight.

2011. What is the amount of the usual attendance?—They pretty tolerably attend when anything particular is going on.

2012. (Mr. *Hume.*) What class of people are they?—There are 12 Commissioners from the landed interest; 12 Commissioners from the corporation; 12 Commissioners holding certain quantities of shipping; and 12 Commissioners from the householders.

2013. Has the navigation been improved since 1839, when that groin was established.—Decidedly not.

2014. What is the depth of water now up to Rye?—We have got up to the town about 10 feet water at high-water spring-tide.

2015. How high does the tide rise?—About 22 feet in the Rye Bay.

2016. Have you in your possession any old map of what the harbour of Rye some centuries ago was?—I think the earliest is Smeaton's.

2017. What year was that?—1750, or thereabouts.

2018. What was the state of the harbour at that time?—There was then the new harbour, but they have resorted back to the old one now.

2019. Where was the new harbour there?—To the westward, close under Cliff End.

2020. (*Capt. Washington*). Why was the old harbour shut up?—In consequence of the beach, which is always shifting from the west to the east. When I say it is always shifting, I conclude that three-fourths of the time we have winds from westward, compared with what we have from the east, because if you have a long range of easterly wind, the beach then shifts to the westward; but the prevailing wind is the south-west, consequently it brings the beach

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along the shore in greater force than it is carried back again. But the great thing we have also to contend with in Rye Harbour, is Fairlight Cliff, which is constantly falling down; that is composed of clay, and it lies about in the bay, and in gales of wind from the south-west, it is washed to pieces, and forms an alluvial deposit, and which it has done from time immemorial; a great part of Romney Marsh is composed of it. After a gale of wind, you may see large lumps of clay rolling about the mouth of the harbour.

2021. (Mr. *Hume.*) Whereabouts is Fairlight Cliff, as connected with the town?—About six miles to the westward.

2022. How far does the tide flow up the river Rother, beyond the town of Rye?—There are three rivers—one called the Brede, the Tillingham, and Rother.

2023. They have all sluices, and where?—All within a mile of the town.

2024. Do these sluices stop the flow of the tide?—Decidedly.

2025. How high above those sluices would the tide flow, if there were none?—I should say the water would not flow more than five miles up the Tillingham. Up the Rother it would flow ten perhaps, and the Brede about seven.

2026. At what times where those sluices erected?—Three of them were erected 50 years ago; they are now destroyed, and they were renewed about 10 years ago.

2027. Were they erected by Act of Parliament?—Yes.

2028. Is there any record to show what quantity of water was prevented flowing up by the erection of these sluices?—I cannot speak to that, because it is so long ago.

2029. Have you any means to show how much land was covered by the tidal water before those sluices were erected?—No.

2030. What is the greatest depth of water that has existed up to the town of Rye for ships within the memory of man?—I do not think it is much narrower than it used to be, or else the depth is not much different.

2031. (*Capt. Washington.*) Do not you recollect Scot's Float Sluice being broken down?—Yes.

2032. (Mr. *Hume.*) In what year was that?—In 1813.

2033. By whom was it broken down?—By the tide.

2034. What was the effect upon the tide after it was broken down?—It went up the River Rother.

2035. How long was that sluice down?—About two years.

2036. What was the effect upon the harbour of the tide flowing up during that time?—It deepened it to a certain extent, but I do not know that there was a great deal of difference.

2037. Was there any engineer employed at that time, or have you any report of what the effect on the depth of water in the harbour was at that period?—Mr. Rennie's must be the nearest to it, but what that contains I cannot recollect.

2038. By what authority was that sluice shut up again?—By Act of Parliament.

2039. (Mr. *Rice.*) By what means was it paid by the Act?—By a scot on the land all above the sluice.

2040. (*Capt. Beaufort.*) (To Mr. *Manser.*) Was there much land inundated and damaged by the sluice being broken down?—I believe there was.

2041. How much?—I cannot say.

2042. Could that land be preserved by parallel embankments instead of being shut off by a sluice?—I think it could, at a very great expense.

2043. (*Capt. Washington.*) (To Mr. *Stocks.*) Do you remember when Scot's Float Sluice was down two years, what was the effect on the harbour?—The flux and reflux was a great deal better, by which the harbour was kept clear.

2044. Could not boats at low-water spring pull up to the town?—Yes, at low-water spring.

2045. (Mr. *Hume.*) Had that increased tide come on after the sluice was broken down?—Very shortly afterwards; as soon as the water got its run up into the country.

2046. What was the effect on the bar?—The bar is subject to vary and shift.

2047. Was the bar or entrance at the mouth deeper during the two years the sluice was open?—Yes.

2048. What was the effect after shutting up the sluice?—The west bar projected across the entrance, and turned the water down to the eastward, and made the channel crooked, and the sand accumulated outside.

2049. What was the difference of the flow of the tide in spring tide when the sluice was down?—The in-drift was so great that there would be 2 feet fall at the pier head while the water was still running in at spring tides.

2050. Do you mean the ground to be filled was so extensive after the sluice was opened that that was the difference of height at the bar and at the quay?—The water before it gets its level up the country would fall 2 feet at the pier-head.

2051. What is the largest vessel you have known during that period come up to Rye?—We have vessels now that come up at moderate spring tide of 11 feet draught of water.

2052. When the sluice was broken down, how many feet water was there?—Nearly the same.

2053. But the current more rapid?—Yes.

2054 Have you not stated that the current was stronger, and that the bank at the bar was also removed?—The out bar was partly removed.

2055. And that on shutting up the sluice one of the banks at the bar shot across and impeded the harbour?—It shifted down towards the eastward.

2056. (Mr. *Rice.*) Had you a better harbour when that sluice was down than you have had since?—Yes.

2057. (*Chairman.*) Is it your opinion that the shutting up that sluice tended to injure the

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harbour of Rye considerably?—I contend that where there is a flux and reflux tide, and the tide has to make a run, the harbour will be the gainer by it.

2058. If you had the full run of the tide 15 or 16 miles up, from your experience, what would be the state of the bar, allowing for the drift of the shingle from the east or west winds, as they may prevail?—The bar is liable to shift according to the summer or winter freshes, or prevailing winds. There is generally a shifting of the bar twice a year. In the winter freshes, when the tide runs strong, sometimes they carry a straighter passage out.

2059. If the sluice had not been erected, and the tide had full flow 10 or 12 miles upwards, would not that current have tended to keep the harbour still clear?—With proper works to be erected; but when a tide comes below the two extreme points and expands, different channels will be formed; and where ever it expands outside the works that are carried on the expansion of the water lessens the force of the current.

2060. If the volume of water was increased, and the current also increases, the entrance would be improved?—Yes, by the works now carrying on to the eastward.

2061. (*Capt. Beaufort.*) Have you ever dredged the channel at all?—We have no opportunity: our funds are so limited, that we have no property to do it.

2062. Would dredging be a great advantage to you in clearing the channel?—I think it would.

2063. (Mr. *Hume.*) (To Mr. *Hicks.*) What is the revenue arising at the harbour?—The average of late years has been 1300*l.*, but since the South Eastern Railway has taken off a great deal of the trade, only about 1000*l.*

2064. How is that raised?—A shilling a ton on the registered tonnage on all loaded ships coming into the harbour.

2065. How is that expended?—On the harbour in various ways.

2066. On works?—Yes, for instance, erecting that eastern jetty has cost a great deal of money.

2067. On the average of the last 10 years, can you state precisely the revenue from the harbour?—About 1300*l.*

2068. (Mr. *Rice.*) And that has now diminished?—That has diminished to 1050*l.*

2069. (Mr. *Hume.*) How has that been expended?—For the purpose of paying interest of money in some instances, and otherwise towards erecting this central pier, and a variety of other works.

2070. Is there any debt at present on the harbour?—Yes.

2071. To what amount?—1500*l.*

2072. (Mr. *Rice.*) (To Mr. *Manser.*) Was that Act of Parliament for making that sluice obtained by a resolution of the Harbour Commissioners, or was it obtained by the land-owners themselves?—By the Commissioners of sewers.

2073. (*Capt. Washington.*) Whose money paid for the erection of it?—The land-owners.

2074. (Mr. *Rice.*) There was considerable opposition to it?—Yes.

2075. (*Capt. Beaufort.*) (To Mr. *Hicks.*) And of that 1300*l.*, what are the usual expenses of harbour master, boat, and messenger?—I suppose the standing charges are from 300*l.* to 400*l.* a year.

2076. So that you have about 800*l.* or 900*l.* a year for the improvement of the harbour?—Not more than 600*l.* now.

2077. (Mr. *Hume.*) It appears from your evidence that a considerable amount of money has been laid out, first on one side and then on the other, and that no determinate plan has been acted upon?—Decidedly.

2078. And it is your opinion that if there had been some superintending authority, to whom reference could be made by the local Commissioners, that that would have been in some degree saved?—I am sure of it.

2079. (Mr. *Rice.*) Do you think, if it had been under the superintendence of the Admiralty at the time that the sluice was made, that Act of Parliament would ever have been passed?—I do not know what to say about that; I have my own opinion: I have heard so many opinions; the first great engineers have been down there, and say you ought to have a sluice here, when the general opinion has been against a sluice altogether.

2080. (Mr. *Hume.*) Some of those engineers were employed by the Commissioners of Sewers, were they not?—Yes, and some by the Admiralty.

2081. Who do you mean by the Commissioners of Sewers?—Those who owned land of 200*l.* a-year.

2082. In what position?—On the banks of the River Rother.

2083. (To Mr. *Manser.*) Under what authority were they constituted?—In 1830, I think, the Act was obtained, under which the Commissioners were appointed and are now acting.

2084. Do you know whether any portion of the harbour dues has ever been applied by the Commissioners of Sewers to embank the lands which they had?—Not above the sluice.

2085. Below the sluice have you known it?—No.

2086. Do you consider those embankments and improvements below the sluice have improved the harbour?—No, I do not think they have improved or injured the harbour.

2087. Have they shut out a large portion of tidal water?—The water has flowed over 734 acres where it does not flow now.

2088. (To Mr. *Stocks.*) What has been the state of the bar since these 734 acres were inclosed?—There has been very little difference in the state of the depth of the water, but the channel from the harbour has narrowed considerably for want of that quantity of water that used to flow over; the harbour has narrowed considerably since the embankment has been down. The depth of water in the guzzle or channel is nearly the same. For want of flow these artificial scours have not force enough to carry away the silt that settles at a high tide, but only keep the bottom clear.

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2089. The width of the channel has been considerably decreased?—It has.

2090. The flow of water has not been sufficient to carry out the silt beyond the mouth?—No.

2091. Do sailing vessels go up to Scot's Float Sluice?—They are all sailing vessels.

2092. (*Capt. Beaufort.*) What height are their masts?—70 feet is the highest.

2093. Are they made with falling masts?—No.

2094. (Mr. *Hume.*) Would the erection of those bridges stop the navigation up to that sluice which you have now stated?—Entirely.

2095. If the sluice was removed entirely, how much higher could these vessels go?—The bridge would only allow them to go three miles.

2096. Do they narrow the channel much?—A little.

2097. Do any barges or boats go to the westward?—Continually.

2098. Carrying stores or goods?—Coals, chalk, and merchandize up and down.

2099. How high up the stream does any boat go with coal or other articles?—To Bodiham Castle.

2100. How far is that?—About 15 miles.

2101. Then the navigation interrupted by that sluice for large vessels is continued to boats for 15 miles beyond it?—It is.

2102. During the time that the sluice was down, are you able to state what sized vessels could have gone up to that castle?—None; the sluice being down, would not have permitted the vessels to go further than the bridge.

2103. Supposing the bridges across the river were removed, and the sluices removed, and the flow of the tide permitted, to what extent do you consider the navigation of vessels above 60 or 70 tons could be carried above Scot's Float?—It is a delicate question to be answered, it having been so long shut up. There is no telling what effect the run of tide might have upon it.

2104. Do you know what depth of water there is now with all the bridges across, and what boats go up to that castle?—No; at spring tide I suppose vessels of ten feet water may go as far as Newenden.

2105. Judging from the effect by the scour of the tide when the sluice was down, do you expect that the channel throughout would be deepened if the tide was allowed to flow up?—It would be a natural consequence.

2106. Have you ever any great floods down the Rother and the other three rivers flowing into it?—The floods are so great at times in the Rother with very heavy freshes, that barges can scarcely get under the bridges.

2107. Would not these freshes, if there was no interruption to the navigation, tend gradually to deepen above, and also to improve the bar below?—The sluice-keeper is as glad to get rid of the freshes as he can possibly be, and he opens the gates and every thing when there is a fresh that the land may not be flooded. There would not be more down-set than there is now.

2108. (Mr. *Rice.*) I suppose they would run the sluice at low water?—Yes.

2109. (Mr. *Hume.*) You would have the benefit of the flood tide?—Yes; in keeping it moving, both ebb and flood.

2110. (Mr. *Rice* to Mr. *Manser.*) Does the plan annexed to the Act of 1833 represent what the harbour was before the passing of that Act?—Yes.

2111. At that time was there a large creek in the harbour which is now inclosed by the embankment?—Yes.

2112. (To Mr. *Stocks.*) Do you know at all what was the depth of water in that creek?—Dry at low water.

2113. (Mr. *Hume.*) What was it at high water formerly?—Ten or eleven feet.

2114. (Mr. *Rice.*) Was that made any use of for boats, or any purpose at that time?—None; there was a dam thrown across 57 years ago to stop that channel, but at the place where they had put the wall across at the lower end, it was not stopped. The upper part was stopped, and that turns all the water into this north channel.

2115. That creek is now banked off and is dry land?—Yes; there was a number of creeks up and down on both sides, which is now all silted up.

2116. (Mr. *Hume.*) Do you consider that those creeks and the marshes that are now shut out, being full of water, had any effect on the bar in clearing the harbour low down?—The effect of the channel of the harbour by the late embankment has been to narrow the sides of it and confine the water to a narrow compass below, so that a barge can scarcely lie alongside a vessel in the channel.

2117. Are the Commission to understand that from want of current to sweep out the silt, it has increased on both sides until a vessel and barge can scarcely lie abreast of each other?—They cannot.

2118. (*Chairman.*) (To Mr. *Manser.*) Whereabouts do the South Eastern Railway Company propose to cross the harbour channel?—On the eastern side of the Fish Market.

2119. (Mr. *Rice.*) How much is that below Scot's Float Sluice?—A mile.

2120. (Mr. *Hume.*) What is the distance from the town up to Scot's Float Sluice?—About a mile and a quarter.

2121. Is it navigable all the way up?—Yes.

2122. For what size vessel up to the sluice?—Vessels of 80 tons go up.

2123. Is there any jetty or harbour for landing at the sluice?—Yes.

2124. What goods are landed and shipped there?—They consist principally of chalk, coal, and also a quantity of agricultural produce is exported.

2125. (To Mr. *Stocks.*) Have you any return of the amount annually landed and shipped?—I have.

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[*The Witness delivered in the following Document*] :—

STATEMENT of the Number of Vessels which pass up the River leading from Rye Harbour to Scot's Float Sluice, above where the projected Railways are proposed to cross the River in each Year, on an average of Five Years :—

Coal-laden vessels, averaging from 70 to 100 tons	12
Chalk vessels to Mr. Smith's kilns	32
Vessels with rags or shoddy, and small vessels to Pollard's Wharf .	10
Vessels that lay out chalk below Pollard's Wharf, about . . .	60

Independent of which there have been about 20 vessels with stone and cement within the last three years.

2126. What is the width of the river at the spot where they propose to pass?—102 feet at low water.

2127. At high water, at a common spring tide, what is the width?—About 250 feet.

2128. Do the banks overflow so far as 70 feet on each side?—From low water mark.

2129. (Mr. *Rice.*) Is there an embankment of the land there?—There is an embankment on both sides.

2130. What is the distance between the land embankments?—About 250 feet.

2131. At high water spring tide, how near to the top of the banks does the water flow there? —From 18 inches to 2 feet.

2132. (Mr. *Hume.*) What is the height of the embankment above the level of the land?—In some places 4 feet, and in others 5 feet.

2133. If there was no embankment there, the whole of that land would be covered 3 or 4 feet deep with water during high water spring tides?—Yes.

2134. (To Mr. *Hicks.*) Can you state from an examination of the plans what would be the height of the bridge above the embankment to which you have now stated the water comes sometimes within 18 inches?—The Brighton Railway Company and the South Eastern Railway Company propose to cross within 36 feet of each other. The level of the Brighton is 1 foot under the top of the banks under the flow of high water, and the other is about 6 feet above.

2135. (To Mr. *Manser.*) Have you seen a section, and can you give a correct opinion at what height it is intend to cross the stream?—In the Brighton line the section shows a distance of only 4 feet 6 inches from the bottom of the intended bridge to the surface of the water at high spring tide. The South-Eastern shows a distance of 12 feet 6 inches between the bottom of their intended bridge and the surface of the water at high water.

2136. What span do they intend to cross it with, one arch?—I have not seen any drawing or specification of the intended bridge.

2137. You do not know whether any pier is to be placed in the middle, or whether it is to be a swing or a single arch?—I do not.

2138. (*Chairman.*) What effect will either of these bridges have on the navigation?—In whatever way the bridge is built it will be most injurious to the navigation. If it be what is termed an open bridge, on piles, it will stop the passage of all rigged vessels up to Scot's Float Sluice. If it be a swing bridge (owing to the nature of the channel, for I believe there are nearly 30 feet of silt above the bed of the present channel) the works to support it must be of that massive character, and the greater part of them in the middle of the channel, and must of necessity obstruct the flow of water.

2139. (Mr. *Rice.*) Looking to the importance of the flow of water and rigged vessels going to the sluice, which do you think would be the greatest detriment to the harbour, making a swing bridge with piers in the centre. and a much narrower channel, or an open bridge, which would not so much obstruct the navigation?—I am decidedly of opinion, the swing bridge would be the greatest injury.

2140. (*Capt. Washington.*) Can you point out where the railroad might cross without damage to the navigation?—On the north-eastern side of Scot's Float Sluice, without any injury.

2141. (Mr. *Hume.*) Supposing that sluice to remain?—Yes; I believe they might even cross Scot's Float Sluice itself, with a very trifling alteration.

2142. Are there any quarries in any part of the country on the banks of the Rother, to the westward of where the sluice is now?—I do not know.

2143. What probable chance is there of any great intercourse taking place up that river, if the navigation was improved?—I do not know of any increase.

2144. If the navigation was improved up to the 10 miles, would it afford any great facility to the agricultural produce?—No; I think it would not, because they have at present as much channel, and as much water, as they want for getting up barges of the description that usually navigate that channel.

2145. Are these barges loaded and unloaded from vessels below the sluice?—Yes; with reference to a swing bridge at the point they propose to cross the channel, (and I am borne out in my statement, by the opinion of the pilots, and nautical men in the habit of navigating that channel,) it would be almost impossible to get the vessels through. It would be difficult to direct the course of the vessel, in consequence of a very extraordinary set of tide, at a place called Fish Market, which is only a few yards to the westward, where they propose to cross the channel. The set of tide is so strong now, that vessels are driven from their moorings, and are carried down below the point where they propose to erect the bridge.

2146. What is the rapidity of the current?—From four to five miles an hour at the first flow and when they have got ten feet water in the channel it increases to six or seven.

2147. If a bridge is thrown across at all, not to interfere with the navigation, must it go from bank to bank, the river being 250 feet in width, and whatever height might be required for the vessels?—I should say at least 80 feet would be required in height.

2148. What is the state of the banks on each side?—The banks are about 10 feet high on each side.

2149. Consequently, to give height to any vessel with masts, an embankment to a considerable height must be raised?—Yes.

2150. At what distance from Rye, in a direct line, is the place where they could cross without interfering with the present navigation?—About a mile and a half.

2151. You have stated that vessels with masts could not pass if that bridge was erected; could barges such as go up to Bodibam Castle, to bring down the agricultural produce, pass? I believe they would have very great difficulty in passing until half-tide, and even then I think they would not pass. I have seen a barge carried down with the tide at flood, and another barge coming up at the same time, the current running in opposite directions; and sometimes you will see the tide setting in opposite directions, operating on the fore part of the boat, and another current abaft.

2152. Does that arise from projecting points on either side?—It arises from the eddies.

2153. (Mr. *Rice.*) Do you know the fact that this bridge will narrow the channel in that case?—They might erect bridges without narrowing the channel—open bridges.

2154. Except as to rigged vessels, if they did not narrow the channel at all, would they affect the passage of barges?—Yes. If the current set in a straight forward direction through the whole of the arches of the bridge, there would be no difficulty in passing a barge through.

2155. Supposing there were an arch and no piers, and the channel not narrowed?—Then it would not affect the current at all.

2156. (Mr. *Chapman*) Supposing it was a draw-bridge, could not the railway be made to pass a draw-bridge?—If it were a draw-bridge all the works must be in the centre of the channel, because a draw-bridge would not contain an opening of more than 33 feet, while the distance from bank to bank is 250 feet.

2157. (Mr. *Rice.*) Supposing they gave a side opening that would give as great a facility for the flow of water up there, as far as the flow of water goes, would the erecting of a swing bridge affect it?—The flow of water would be much obstructed by the centre piers, because they must be of a massive character; and I also think they would not be able to get them to stand, in consequence of the unsound state of the foundation, without filling in on each side. If they do, the water way will be contracted to 33 feet, whereas now they have a water way of nearly 250 feet.

2158. (Mr. *Hume.*) Have you any means of knowing what the foundation at that part is?—Yes, we probed it. The bed of the river consists of alluvial matter, to the extent of at least 20 feet below the surface of the bed.

2159. How was that ascertained?—By the harbour master.

2160. (To Mr. *Stocks.*) Have you seen the bed of the river, where it is proposed the bridge should pass, bored to ascertain the nature of the soil below?—No, I have probed it with a small iron rod as far as I could get it down by hand.

2161. How far have you probed it?—About eight feet.

2162. Did you find much difficulty in going down eight feet?—No.

2163. Is it a soft boggy soil, or what?—It came up muddy.

2164. Is that below the low-water mark?—Even with low-water mark.

2165. Was that in the middle, or at the side?—Near the side. I was sounding for the platform of the tide sluice that was there formerly.

2166. How did you know of that sluice?—By reports from the barge people putting their poles on it, and pushing the bars up and down.

2167. Did you find any of those foundations?—I found the platform of it.

2168. How deep was the platform below?—About three feet from the surface of the water; about a foot and a half under the sand.

2169. Is that now there?—Yes, that is near the place, as far as I can understand, the proposed bridges are to cross the river. Any contraction of the river beyond a very great distance would be very injurious and dangerous to the barges.

2170. (To Mr. *Hicks.*) Have you, during your residence at Rye, had any opportunity of ascertaining what is the foundation in that neighbourhood below the surface?—I have; it is alluvial soil.

2171. Firm or loose?—Loose alluvial soil, sand, and mud.

2172. No bog?—None.

2173. (Mr. *Rice.*) Beach in any case?—I never found any beach.

2174. (Mr. *Hume.*) Have you any shingle to the northward and westward of the town of Rye, in the river?—None; there was formerly an old ford way.

2175. How high up is that fordway?—About a quarter of a mile. In speaking of the advantages that were derived when the sluice was up, it was stated by me that I did not conceive that the harbour was greatly improved. Mr. Stocks has stated there was water up and down. I wish to be clearly understood. At the bottom of the channel there was very little difference, but that the immense bulk of water that remained up the country continued to run down, and that gave the water in the harbour; it did not give it on the level on the bottom of the channel.

2176. (*Capt. Washington*) Do you mean to say it did not scour out any of the channel?—It did, but not to the extent stated by Mr. Stocks. The water was caused by its coming out of the great reservoirs in the country.

2177. As far as navigation is concerned, the practical effect was that you had water up to the town at low water spring, whereas now you have a dry bank?—The water was continually running down, and therefore it left more in.

2178. (Mr. *Hume.*) At present have you any run of water past the town of Rye at all times?—Yes.

2179. What depth?—Some places not more than six or eight inches, and there are in some two feet.

2180. Does the current continue running until the flood comes in?—Decidedly.

2181. (To Mr. *Stocks.*) After the sluice had been opened for two years, what quantity of water used to flow at ebb past the town of Rye, as compared with the present?—I believe from the time the sluice first gave way it was rebuilt in two years. During that time the drain of water from the country would bring barges down light with the ebb tide at low water.

2182. Are the Commission to understand that from the sluice down to the harbour's mouth barges drawing 2 feet water could then go out at low-water?—Yes.

2183. At present no barge can go?—They are catching the ground every little way with banks.

2184. In fact, do they go now?—It depends greatly upon whether there is a run in the country, and whether much fresh comes down.

2185. If there is no ebb can they come down?—They cannot.

2186. (*Capt. Washington.*) What is the rise of tide at the town of Rye at spring tide?—Fourteen feet.

2187. What is it at the bar?—It is from 22 to 24 feet in the bay.

2188. (Mr. *Rice* to Mr. *Hicks.*) Are you largely engaged in the coal business at Rye?—Yes.

2189. Do you send a great quantity of coal in barges up the river above Scot's Float Sluice?—Yes.

2190. Where do you unload your vessels and put the coals into barges?—At Stag's Hole.

2191. Is that below the place where the proposed bridge is to be?—A great way below.

2192. Might you not, if you thought proper, unload your vessels at Scot's Float Sluice?—Yes.

2193. But you do not think it necessary to avail yourself of that advantage, and you unload them at the town?—Yes.

2194. A great many vessels go up loaded with chalk?—Yes.

2195. Are they mast vessels?—Yes.

2196. And they unload at Scot's Float Sluice?—Yes.

2197. What would be the difference of expense to these parties who now unload at Scot's Float Sluice if they were obliged to put their chalk and coals into barges below the present proposed bridge?—The expense to the chalk would be small comparatively, only there would be great inconvenience from want of room to lay it. The coal would cost one shilling a ton more at least.

2198. (Mr. *Hume.*) If the sluice was removed the vessels would go higher up?—I have no doubt they would.

2199. Have you any means of ascertaining the quantity of goods carried through the sluice up the country?—I have.

2200. What is your duty as Admiralty Commissioner; how are you appointed, and what have you to do?—I will answer that question by reading the following letter.

"SIR, " *Admiralty*, 11*th July*, 1833.

"I AM commanded by my Lords Commissioners of the Admiralty to acquaint you that it is their Lordships' wish to name you a Commissioner for Rye Harbour, under the provisions of an Act of Parliament passed in the present Session, entitled 'An Act to alter and amend the Powers of several Acts passing relating to the Harbour of Rye, in the County of Sussex, and for granting further powers for improving and completing the said Harbour, and the Navigation thereof.' And I am to request that you will communicate to me for my Lords' information any thing which may concern the Admiralty.

"I am, Sir,
"Your very humble obedient Servant,
"JOHN BARROW.

"*Charles Hicks, Esq., Rye.*"

2201. You were appointed in 1833?—Yes.

2202. Have you acted since then?—I have.

2203. The difference of opinion which you express, between you and the other Commissioners, was expressed by you as the Admiralty Commissioner?—Yes.

2204. Did you make any representation at that time to the Admiralty of the difference of opinion, and the alteration that was going on?—I did.

2205. In reports?—Yes.

2206. Were these representations attended to?—I never had any answer from them. I wrote once to be instructed in my duty, to which I never had an answer.

2207. Are there any other Admiralty Commissioners authorized by that bill?—No.

2208. Does the Bill authorize only one?—Only one.

2209. If there had been a majority of Admiralty Commissioners, would matters have gone on as they have done in that harbour?—Not if they had been of my opinion.

2210. Your Act of Parliament would have prevented building up first west, and then east, and then west and then east piers?—Yes.

2211. You would have had some definite plan to go upon?—Certainly.

2212. (*Capt. Washington.*) I see an embankment across a piece of water called the Nook or Greedy Gut, to the westward of the harbour; when and by whom was that made?—In 1839 by Mr. Shadwell.

2213. What authority had he to make such an embankment?—He had no authority.

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2214. (Mr. *Hume.*) Who was Mr. Shadwell?—He was a man of large property living at Hastings.

2215. Had he property there?—He purchased that property.

2216. Is it under high water mark?—Yes.

2217. (*Capt. Washington.*) Does the tide flow up beyond that?—Yes.

2218. What distance? to a mile and a half?—He has made two wharfs, and it is more than a mile. The water rose at the bank three feet at high water.

2219. Over what extent?—From 200 to 300 acres.

2220. Did that water, then, amounting to upwards of 10 million cubic feet, or 300,000 tons, scour over your bar at all spring tides?—There was a great flow of water all the way round, and a great many patches of land were filled by the water.

2221. And that helped the scour at every ebb tide?—There was a great run of water out.

2222. (To Mr. *Hicks.*) Do you know under what authority that water was embanked out?—No.

2223. (Mr. *Hume.*) Did you report it to the Rye Harbour Commissioners?—No; there is Camber Castle situate on the banks, and it was stated that when that castle was built, you could throw a biscuit from the shore to the castle; Mr. Cubitt and I therefore went over, and it appears according to our calculation, that the 'fulls' or ridges of shingle advanced at the rate of one in every 19 years, from the time the castle was built.

2224 (*Capt. Washington.*) Did you report to the Admiralty Commissioners this encroachment on the harbour?—I did not report it to the Admiralty; but I pointed it out to Mr. Cubitt, because I understood it was beyond the jurisdiction of the harbour.

2225. (Mr. *Hume.*) (To Mr. *Manser.*) Do you recollect the people collecting at Rye, and the neighbourhood to destroy Scot's Float Sluice?—Yes.

2226. What year was that?—1830.

2227. Can you state the circumstances connected with it?—Proceedings in Chancery were instituted by the late Mr. Curteis, the Member, in which suit a Mr. Clarke was defendant. In consequence of that suit, the Court of Chancery directed an issue to be tried as to whether Scot's Float Sluice, as then erected, was or was not a nuisance to the navigation. That issue was tried in the county of Surrey, in order that a disinterested jury might be had; and that jury found that Scot's Float Sluice, as then erected, was a nuisance; but that, if certain alterations were made, it would not be a nuisance. A decree was made in accordance with the verdict of the jury, but the alterations were not made. Then the Commissioners of Sewers applied to Parliament, and in the preamble of their Bill, they set out that the alterations which the Court of Chancery had directed to be made were found to be unnecessary, but that other alterations might be made with greater advantage. Those alterations were made, and they got their Act of Parliament legalizing the erection of that sluice with those alterations, and the sluice was erected in conformity with it. The reason why the sluice was partially pulled down was, that the decree of the Court of Chancery had not been fulfilled within the time therein specified.

2228. What year was that?—1830.

2229. What means were taken to prevent it being destroyed?—By calling in the aid of the military.

2230. How long did the military remain there to protect it?—As near as I can judge, about a week.

2231. Was any representation made at that time to the Admiralty or to the Government on the subject?—Yes.

2232. By whom?—By the town of Rye.

2233. To whom was the application made?—There was an application made to the Admiralty; and at the time that application was made, the Commissioners of Sewers were before Parliament, endeavouring to get an Act of Parliament to authorize the rebuilding of the sluice.

2234. Can you obtain a copy of that representation from the archives of the town of Rye?—I do not know that there is any copy; I think among the Admiralty archives it would be found.

2235. Notwithstanding that representation on the part of Rye, the Commissioners of Sewers were allowed to get their Bill, and erect the sluice without carrying out those improvements which the jury had pointed out?—Yes.

2236. Since then, have any complaints been made on the part of the inhabitants of Rye against it?—I have not heard of any.

2237. The Act of Parliament, you think, settled that?—Yes.

2238. (Mr. *Rice.*) (To Mr. *Manser.*) When those embankments were enclosed, did the Harbour Commissioners receive any compensation from the parties enclosing it for the value of that land?—They received nearly 7000*l.* altogether.

2239. At how much per acre?—There was a standard of 14*l.* 10*s.* an acre fixed, and the other land was valued in reference to that.

2240. Was the expense of making the embankment partly defrayed by the harbour dues?—It was paid out of the money which the Harbour Commissioners received for compensation. The harbour dues remained untouched.

2241. (Mr. *Hume.*) Was the whole of that 7000*l.* applied to raise the embankment?—Not the whole of it; some portion of it was left.

2242. What became of that?—It was invested on mortgage.

2243. (*Capt. Washington.*) Are the Commission to understand that the Rye Harbour Trustees were consenting parties to the erection of this embankment, which you have admitted, enclosed upwards of 700 acres of marsh, covered to the depth of three feet at spring tides,

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thereby excluding above 30,000,000 of cubic feet, or 870,000 tons of water, and losing its scour on each spring tide?—Yes.

2244. (Mr. *Rice.*) A part of that arrangement was to receive compensation at so much per acre?—Yes.

2245. (Mr. *Hume.*) Were any of those Commissioners proprietors of the adjoining land?—Three of them.

2246. All influential proprietors in the neighbourhood?—Yes.

[*The Witness withdrew.*]

Adjourned till Friday next, at one o'clock.

Friday, June 13th, 1845.

Present :—

Rear-Admiral BOWLES, C.B., in the Chair.

Mr. Hume, M.P.	Mr. Godson, M.P.
Mr. Rice, M.P.	Captain Washington, R.N.
Captain Beaufort, R.N.	

Mr. *James Walker*, C.E., sworn and examined.

Mr. *James Walker.*

June 13, 1845.

2247. (*Chairman.*) There has been referred to this Commission by the Admiralty for our opinion, the question of the proposed bridge of the Glasgow Junction Railway over the Clyde, and to report as to the site and dimensions; will you be so good as to state its site and dimensions?—They would be better stated by the engineer to the Bill. But I am enabled to say that it is proposed to erect two piers, each about 15 feet wide, in the Clyde, and to carry a single line of rails upon them; the distance from the present Glasgow Bridge to the face of the new pier being 47 feet, and the breadth of the bridge 16 feet.

2248. What is your opinion as to the general effect of the proposed bridge on the navigation of the river?—The principal effect is taking about 60 feet from the present harbour, the height being such that the mast or funnel of a steamer cannot get under it, but which the stern of a steamer may get under. The height of the middle arch is from 30 to 35 feet above high water, and the spring of the arch will be about 22 feet above high water. A little way above the proposed bridge is the Glasgow Bridge which has six piers, the average of which is 8 feet 6 inches, therefore the present piers take up 51 feet, and the proposed bridge will take up 30 feet of the water-way; but the piers being 15 feet, and opposite to piers which are 9 feet, form at that point a greater obstruction than one of the 9 feet piers.

2249. (Mr. *Hume*) What portion of the shipping trade is carried on above the proposed bridge?—It has been given in evidence that the steamers at present come close up to the bridge, and that these piers will be an obstruction to their lying so near to the bridge as they now do, and also to their turning. I have no doubt that is the case, at the same time I must freely confess, that although taking off that piece of the river diminishes the length of the harbour of Glasgow, if it were a very important object to cross the river by such a bridge, which I do not think it is, the harbour interest perhaps ought to give way to the land interest.

2250. (*Chairman.*) Are you aware of any way in which this inconvenience may be avoided altogether?—Yes; I suggested to the Committee that the inconvenience may be avoided by not crossing the river at all, nor (which is certainly in my opinion the greater evil) going through the city and through the very best part of Glasgow, and under it, by leaving the Glasgow and Ayr Railway, before entering the town. The difference of distance is two miles and a half, but the resistance is not in that proportion, because the difference of level between the point of starting and the summit, are in both cases 151 feet, and the gravity up and down has more to do with it than the horizontal resistance or friction.

2251. (Mr. *Hume.*) Where then would you propose to cross the river, to get to the point in the north?—A quarter of a mile above Rutherglen Bridge.

2252. Is any navigation extended beyond that point?—No, only for boats; and the lift of tide there is very trifling indeed, perhaps not a foot.

2253. Consequently if other impediments in the river below were removed the new line would not at all prevent the improvement?—No.

2254. (*Chairman.*) Are you aware of any intention of taking away the new Glasgow Bridge for the purpose of improving the navigation of the Clyde, and of enabling vessels to come higher up the river?—I never heard of it till this instant.

2255. Do you think it would effect it?—It is practicable, but I do not think it at all expedient. The space between the present Glasgow Bridge and the Stockwell Street Bridge is being formed (which complies with a report I made many years since) into a basin or harbour for river boats and small craft which come under the bridge.

2256. (Mr. *Hume.*) For extending the harbour accommodation for small vessels and leaving below that bridge the larger?—Just so. I do not consider that the two piers, in preventing the tide getting up into the country are of much, or indeed any consequence; in preventing the land floods getting off their obstructing the fair current would have more effect, but this also would be small.

2257. Would not these two piers, by coming opposite the piers of the bridge above, be to a certain extent, an impediment to the flow of the tide?—Practically they would not, the velocity of the tide being small.

[*The Witness withdrew.*]

Mr. *John Miller.*

June 13, 1845.

Mr. *John Miller*, Civil Engineer, sworn and examined.

2258. (*Chairman.*) You are engineer to the Glasgow Junction Railway Company?—Yes.

2259. Have you a plan relating to the proposed railway passing through the town of Glasgow and over the Clyde?—I produce the Parliamentary plan of the whole scheme, showing the crossing of the Clyde, both in line and elevation.

2260. Whereabouts is it proposed to cross?—Below, or to the west of the new Glasgow Bridge. It is 57 feet between the west side of that bridge and the centre of the proposed railway.

2261. How many piers do you propose?—Two piers in the river, and each pier is proposed to be 15 feet wide. The height of the arches is 36 feet 6 inches over what we have stated as the high water. I have been led to understand we have stated the high water three feet too high. If so, the height would be 39 feet 6 inches above high water, but the high water which I have assumed being in a river the high water is not very permanent in its rising. I have taken in 33 feet 6 inches in the cowl of the arch.

2262. (M. *Hume.*) What will be the height at the spring?—The way in which it is proposed to place the piers is, that they should expand with three arches, having a wharf on one side, or rather a wharf on both sides, under the centre, or nearly under the centering, of each side arch. The middle arch stands entirely in the water. The two side arches are partly over the water, and partly over the wharf. The rise of the arch is 14 feet.

2263. What is the clear water-way from quay to quay?—The clear water-way at that part of the river is 430 feet.

2264. You propose to take off by the two piers 30 feet from the water-way?—Yes: 15 feet occupied by three piers, and placing these piers immediately in the line of the piers (which are smaller) of the existing bridge. The existing bridge, I think, has six piers, running from 8 to 9 or 10 feet, averaging, I believe, about 8 feet 6 inches. This scheme is proposed to place two piers, and to have each of these piers, though wider, placed in the same line of current, as it were, of the existing piers.

2265. If that was erected, there would be two parallel bridges, with a distance between them of 57 feet?—Yes.

2266. Would not the railroad in that case interfere with all horses and carriages, and everything passing so near?—No; it is elevated; our bridge stands about 20 feet above the present bridge. It is a cast-iron bridge, and it is proposed to put up an iron railing on each side, and to construct that so as to form a screen, by which trains passing along the bridge would not be observed by horses or animals.

2267. What kind of pier do you intend to make?—A stone pier.

2268. Have you tried the foundation?—Yes; it is sand to a great depth.

2269. Do you know how deep the foundation of the bridge next to it was carried?—The piles, I think, are from 12 to 15 feet. The present bridge, which was built by Mr. Telford is founded on the sand, and it is proposed to follow the same plan.

2270. There would be, then, no difficulty in deepening the river in that part, if it is simply of sand?—The only difficulty is, that if it were deepened beyond what it now is, it would affect the present bridge.

2271. Do you intend to put the piers immediately below or in the same depth as the present bridge?—About the same depth; so that any deepening of the river that could be effected in consequence of the present bridge, could be done, supposing our bridge was erected.

2272. Have you seen any plan by Mr. Bald, for deepening the river considerably upwards, so as to admit vessels of a larger description than now go through the bridge?—I have not. I understand from Mr. Walker, that the extreme depth proposed there is 16 feet, which is below the bridge. That depth cannot be made above there, in consequence of the other bridge; but the bridge we propose will admit of the river being deepened to the fullest extent Mr. Walker contemplates by the present bridge.

2273. What is the distance between the bridge adjoining yours and the next stone bridge above?—The distance between the Glasgow Bridge and the Stockwell-street Bridge is about 500 yards.

2274. (*Capt. Beaufort*) Would there be any difficulty in carrying the railway above all those bridges?—The town intervenes; the very dense part of the town immediately comes on above the bridge at the north end.

2275. Would there be any great difficulty in carrying it above the town?—The bridges go up above the top of the town.

2276. What would be the difficulty?—The difficulty is a great increase of line, and not answering the purpose of making it a thorough line. The new line would require to be made longer by about six miles, according to the scheme Mr. Walker has proposed; but that is not the objection to it. The objection is, that it takes the whole traffic round from Glasgow, and breaks it up so as to be, in my opinion, no public advantage whatever. Allow me to add, our three arches occupy a space of 520 feet; off that there is 30 feet of pier; therefore our three arches occupy 490 feet.

2277. (*Capt. Washington.*) Can you state the height of the soffit of the present Glasgow Bridge?—I think it is not more than 15 feet.

2278. (*Capt. Beaufort.*) What is the proposed span of the centre arch?—180 feet; two piers of 30 feet, and a side arch of 150 feet.

[*The Witness withdrew.*]

Adjourned to Wednesday next, at One o'clock.

Friday, June 27th, 1845.

Present:—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. BREMER, K.C.B.	Mr. RICE, M.P.
Mr. HUME, M.P.	Captain WASHINGTON, R.N.
Mr. GODSON, M.P.	

Capt. Edward Holland, R.N., sworn and examined.

2279. (*Chairman.*) You are a Commander in the Navy, and reside near Truro?—Yes.

2280. How long have you been in the Navy?—Since the beginning of the year 1814.

2281. Are you well acquainted with the harbour of Falmouth?—I am well acquainted with the inner harbour.

2282. Will you state whether within your knowledge any changes have taken place in the state of that portion of the harbour with which you are acquainted?—I should say there are none of that particular portion of it, except where quays or wharfs have recently been built. One or two wharfs have been built. A wharf belonging to the tan-yard at the upper end of the creek, and a small wharf near Glasson's quay.

2283. Are you aware of any decrease or increase?—Not of my own knowledge. I am aware that a very large quantity of sediment is brought down from the mining districts into Falmouth Harbour.

2284. (*Capt. Washington.*) Will you state whether any change is taking place in any of the creeks or branches of Falmouth Harbour?—A change is taking place in Restronguet Creek, owing to the drainage from the mines.

2285. (*Chairman.*) Where do you apprehend that drainage deposits itself?—Chiefly off Miler Point, where the water is decreasing. I do not know that so much from my own knowledge as from having conversed with one of the best and oldest pilots there.

2286. (Mr. *Hume.*) Who has the charge of Falmouth Harbour; under whose authority is it?—The corporation of Penryn claim authority in right of being lessees of the Bishop of Exeter; they exercise jurisdiction over one portion of Penryn Creek; the corporation of Falmouth again exercise jurisdiction over another portion.

2287. How far is the River Fal navigable from Restronguet point?—To Truro.

2288. Who has the charge of that navigation from Truro downwards?—The corporation of Truro claim a portion of it; the corporation of Falmouth exercise jurisdiction over another portion; and the corporation of Penryn over another portion.

2289. (Mr. *Godson.*) Do they claim that under Act of Parliament, or under Charter?—I believe by prescriptive right. I have in my possession an Act of the 22nd and 23rd Charles II., (A.D. 1670,) for building a church, in which reference is made to power given to the proprietors to erect gates, and carry them as far out as they please.

2290. (*Capt. Washington.*) Is there a harbour-master at Falmouth?—No.

2291. (Mr. *Hume.*) Is there any officer having charge of the general navigation of the harbour of Falmouth?—None.

2292. (Mr. *Godson.*) Are you now before Parliament to obtain any Act of Parliament respecting the water at Falmouth?—Respecting a portion of it; we limit our control within certain limits.

2293. What Act of Parliament is it you are seeking?—For the improvement of Falmouth Harbour.

2294. Will you state shortly what are the improvements you intend or wish to make under that Act of Parliament?—To construct a floating harbour in Penryn Creek.

2295. (Mr. *Hume.*) How high does the tide flow above the place where you propose to erect a dock?—Nearly a mile, I think.

2296. Is it navigable from there upwards now to Penryn?—Yes.

2297. What sized vessels, and of what draft of water proceed to Penryn?—Vessels drawing 13 feet water at spring tides, can come up to the town quay.

2298. Will the navigation up to that length, therefore, be stopped during the time sluices are opened?—Yes.

2299. At what rate does the current flow at that spot at present?—Near low water; when the water has left the shoal banks the water runs out pretty quickly.

2300. Will the formation of that embankment across stop the influx of the tide?—It will.

2301. May not that want of scour injure the depth below?—No, it will improve it very much, because we have a very great back water. If I were asked the question what would be the best mode of keeping the inner harbour clear, supposing it did silt up, I should say I would construct this embankment, and by that means have the back water to let out at low water.

2302. Have you ever seen the operation of the sluice back water being applied to clear out?—I have seen one at Hayle, a small but thriving port in St. Ives' Bay, on the north coast of Cornwall.

2303. Have you seen that at Shoreham?—No.

2304. Are you aware that every back water, when let out, causes a hole, and almost immediately loses the strength of sweeping off any of the deposit?—I am aware that is so if you do not form an apron; but if you carry out an apron it will not do so.

2305. To what extent and in what form would you carry out the apron?—I think I should carry it out nearly upon a level.

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2306. To what distance?—That is an engineering question; but I think I should carry it out about 150 feet.

2307. Have you ever seen the back water formed at Dover?—No.

2308. Have you heard that that has failed to have any effect?—I have heard that it has not answered fully.

2309. Has any instance come to your knowledge where a backwater of that sort has had any effect in clearing the channel?—Yes.

2310. What case?—In the case of Hayle it has deepened the channel six or eight feet, and maintains it at that depth. Two Companies have taken the control of that harbour upon themselves, and they have improved it vastly, without reference to the Admiralty or any other body.

2311. What Companies do you allude to?—One is the Copper House Company; I do not remember the name of the other Company.

2312. Are you aware whether they have acted under any Act of Parliament, or with the sanction of the proprietors of the soil?—With the sanction of the proprietors of the soil.

2313. What sized vessels are admitted into Hayle?—Vessels of 200 tons can go in now.

2314. A dock has been made into which they are admitted?—No; merely by the effect of sluicing they have deepened the channel. There is no floating dock.

2315. Is it your opinion that by blocking up the river in Falmouth inner harbour, and making a floating dock, the channel will be deepened better than by admitting the regular flow of flood and ebb?—I think we shall be able to maintain the depth of water just as well as it is now maintained.

2316. In what way do you propose to maintain the channel to its present depth?—By sluicing. Mr. Rendell's report of the 6th December, 1844, states what is proposed to be done

2317. To what distance does he propose to deepen the channel beyond the sluice mouth?—About a quarter of a mile.

2318. Has that Act been passed, or is it in Parliament?—It is now in the House of Lords.

2319. Has any application been made to the Admiralty for permission to do that?—Yes, we have their consent.

2320. Has the consent of the town of Penryn been given to block up the navigation by these docks?—I should say their consent has not been given as a corporate body; but the merchants and a large majority have consented. We have a petition to the Admiralty, signed by 476 of the people in Penryn, which includes, I believe, all the adult population.

2321. You are of opinion that the upper part will not fill up?—Yes.

2322. What is the nature of the soil in the channel from Penryn to the dock?—Mud.

2323. Will the space from the docks to Penryn be kept full of water?—Yes, always.

2324. Will it not silt up?—I think not.

2325. (*Capt. Washington*) Does not all the refuse of the town of Penryn drain into it, as well as the drainage of two small streams?—That is very trifling.

2326. What depth of water is there now up to Penryn?—13 feet at spring tides at the Town Quay.

2327. Is it not dry at half tide?—Yes.

2328. (*Chairman.*) What is the rise and fall?—18 feet on an average.

2329. (*Mr. Hume.*) Then that flow and ebb will be prevented if the space is always to be kept full?—Yes.

2330. In what way will your sluice in that case be useful to clear the lower part of the river?—By waiting till nearly low water, and then letting the water out through sluice-gates; to let it run out in a strong stream near low water, and probably to use mechanical aid to stir up the bottom.

2331. Is it proposed to let the sluice out, and leave the harbour dry?—No; only to certain limits. This is an enormous body of water, about 150 feet. Sluice-gates could not be constructed to let the tide out in one tide.

2332. Will not that show that the quantity of ebb prevented is very great?—Yes; but the engineer states in his report, that he has come to the firm conclusion that that will not injure it. He has taken that point particularly into his consideration.

2333. Has it been well considered whether a deposit will not take place from a dock up to Penryn, where it appears that the ebb will be prevented from flowing?—I have considered it; I think there would be less deposit than there was.

2334. Are you not aware that, from the streams flowing down by Penryn, considerable mud and water must be collected?—No; I am aware that they are particularly clear; they rarely have any sediment in them at all; those streams are as clear as crystal.

2335. Do you speak of the ordinary stream or after flood?—Of the ordinary stream.

2336. Does it not appear that whatever comes down must form a sediment, and cannot be let out?—Yes.

2337. Will not that fill up the channel from the dock up to Pearyn, and thus stop the navigation to Penryn?—No, I think not. When the sea sets in, it causes a little rush up even to Penryn. I have known vessels there moving so much that they could not put the granite blocks on board, owing to the movement of the vessel. The result is, that it causes a wash all along the shore, and that breaks away the clay-slate, of which the banks are composed, which falls down, and becomes mud.

2338. Will not a heavy flood from the land in the same manner bring down portions of earth and mud, and there being no outlet, will it not necessarily be deposited in that basin?—Yes.

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2339. In a few years will not that have a sensible effect on the navigation up to Penryn?—Not more than it does at present.

2340. Why should it not go out with the tide?—It does not; we find there is no mud below.

2341. (*Chairman.*) What depth of water will there be in the proposed basin?—Nineteen feet at neap tide, leaving the four feet between neap and spring tide to use as a scour.

2342. (*Mr. Godson.*) Is this making of the dock, and the cutting off of a mile and upwards of tidal water connected with bringing down a railway to that spot?—It is in connexion with a railway; it is with the hope eventually of making a great steam packet station of the basin.

2343. (*Mr. Hume.*) How far from that do the packets now lie?—About a mile and a-half, in Carrick Roads.

2344. Why not carry the floating dock down to opposite Carrick Roads, where there would be deep water?—Because there would be too much sea. The vessels must lie out in Carrick Roads, which is far from the shore.

2345. Could not a wharf or quay be formed opposite there nearer deep water, without interfering at all with the tidal flow up to Penryn?—No; not for any vessel to come to it with safety.

2346. (*Mr. Godson.*) Has there been any opposition to this Dock Bill and Railway Bill?—There is opposition to the Railway Bill; but this is distinct from the Dock Bill; there has been opposition to this Bill also, but that is now withdrawn.

2347. (*Mr. Hume.*) By whom is this dock to be established?—It is vested in certain Commissioners.

2348. A Joint Stock Company?—No; a public Trust.

2349. By whom?—The Commissioners are taken from the neighbourhood; a certain portion of the Commissioners from the borough of Penryn, a certain portion from the borough of Falmouth, and others from the parishes forming the boundary, and also from those parties who may advance the money to carry it out.

2350. In what way are the funds to be provided?—By whoever will lend them. It is like a turnpike trust. When we have this Act, we shall go to the railway, and say, "Will you advance the money for the purpose of carrying these works into effect;" they will take it into consideration, and probably find it their interest to do so, and will lend the money.

2351. At what time of the tide do you calculate that the packets will be able to sail, supposing they adopt your basin as a place of rest?—At all times, I think. I think at the lowest state of spring tide there will be rarely a case when they cannot sail. It is intended to make 13 feet water at the lowest spring tide in the channel leading up to the dock.

2352. At that spot where the dock-gates are to be placed, what is the depth of water at this time?—At low-water it is dry.

2353. In what way will the packets be able to leave except at high-water?—Under our Act we dredge the tidal basin, just without the proposed floating dock, to 13 feet.

2354. Are the gates of the tidal basin to be sunk 13 feet below the present level?—One of them; the other will be about 8 feet.

2355. Will not the opening of that gate to admit the sailing of packets at low-water or half-tide empty the basin above and leave the larger vessels dry?—No; we place locks between, and lock the vessels up and down.

2356. What size are these locks?—The largest vessels that are constructed can come in,—the "Great Britain" steamer, or any of the West India Mail steamers.

2357. Is the work commenced, or about to be commenced, solely for the accommodation of packets?—Chiefly for their accommodation. Of course we expect that a great trade will come in consequence, if we get these packets.

2358. (*Capt. Washington.*) In the Harbour Trust that you have mentioned are there any sailors?—Several.

2359. Is the harbour of Falmouth efficiently lighted and buoyed?—It is efficiently lighted. It is not buoyed, nor is it essential it should be. If the improvements now before Parliament should be carried out, I should suggest that the channel up to the docks be well buoyed, and a harbour light, not visible from sea, be placed at the entrance of the tidal basin.

2360. From your knowledge of the coast of Cornwall and the Bristol Channel, will you state if there is any want of lights, beacons, or buoys?—I am not sufficiently acquainted with the navigation of the English or Bristol Channels to offer an opinion.

[*The Witness withdrew.*]

Daniel Mackain, sworn and examined.

Daniel Mackain.

2361. (*Chairman.*) What is your profession and place of residence?—Secretary and engineer to the Glasgow Water-works Company, and residing near to Glasgow.

2362. You are desirous of making some statements with reference to any removal of the weir in the river Clyde?—I wish to state that the Glasgow Water-works Company have acquired a right of protection, by means of the weir now existing, from the injury that would result to them if the low-water at their works were reduced to the low-water level of the navigable channel further down, not merely by a decision of the Court of Session after considerable litigation, but also by an express clause in an Act of Parliament.

2363. (*Mr. Hume.*) What is the Act of Parliament which authorizes you to throw a weir across the river Clyde?—The Acts of Parliament direct the Trustees of the Clyde Navigation, in 1825 and 1840, to execute works for the protection of the Glasgow Water-works.

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2364. What Act authorized the Glasgow Water-works Company to throw a weir across?—The works are not done by the Glasgow Water-works Company.

2365. Can you furnish the clauses under which the works have been executed?—Yes.[*]

2366. Did the Water-works Company pay the Clyde Navigation Trustees any money for that?—None. The Glasgow Bridge, which formerly existed at Jamaica-street, was built shortly before the works for improving the navigation were commenced. The operations under the Act of Parliament were commenced about 1775, and that bridge was built at that time. In 1778 the channel of the river was so lowered by these operations that the foundations of the bridge were undermined, and the weir became necessary to preserve the bed of the river at the bridge from being further deepened.

2367. How far are your works above that bridge?—Two miles.

2368. What height is the weir?—The weir is level with the original bed of the river, but the navigable channel below has been lowered by the operations of the Clyde Trustees about 9 feet.

2369. If the weir were removed the channel might be deepened above as below?—It would be deepened to a certain extent.

2370. Is there any navigation that comes up to that weir?—None.

2371. Does the tide flow over it or rise to it?—The neap-tides scarcely go over it, but the spring-tides go 3 feet over it.

2372. At low-water is the bed of the river dry at its foot?—On the side next Glasgow it is dry.

2373. Are there any vessels which come up during high-water near to the weir?—They come up to an extension of the harbour which has been made immediately above Glasgow Bridge.

2374. Through the Glasgow Bridge?—Yes.

2375. How near are your works to Rutherglen?—The Cranston Hill Water-works, which is one of the water-works now forming part of the Glasgow Water-works, is immediately opposite Rutherglen, and the other water-works is one mile above it.

2376. What sized vessels have you seen come up to Rutherglen?—Two (2) punts.

2377. How long have you been engineer to the works?—First of all to the Cranston Hill Works, and, secondly, to the Glasgow Water-works, for 16 years.

2378. Are you aware that Rutherglen was the original port of the Clyde?—No. I had an opportunity of hearing the evidence of some very old men, during the investigation of the question as to the navigation that formerly existed to Rutherglen, before Commissioners appointed by the Court of Session.

2379. In what year was that?—In November, 1841.

2380. Where is there a copy of that evidence?—It is in a process that was carried on at the instance of the magistrates of Rutherglen against the Clyde Trustees and the Bridge Trustees; and the Glasgow Water-works Company were conjoined for their interest.

2381. What was the title of that process?—It was a process originally raised at the instance of the Duke of Hamilton and the Magistrates of Rutherglen against the Bridge Trustees and the Clyde Trustees, to remove the weir. It was commenced in 1807. It lay in abeyance from 1807 to 1834. At that time the Clyde Trustees and the Bridge Trustees proposed to remove this weir. The Water Company objected to it on the ground that it maintained the level of the river at low-water at its natural height, and that, until some other substitute was provided to preserve the water at the same level at the water-works, they would object to its removal. The litigation was carried on until 1841, when it was settled by a joint minute subscribed by all the parties, and a remit was made in consequence to Mr. Walker of London and Sir John Macneil to construct a new weir at Stockwell-street Bridge further up the river.

2382. How much farther up?—About 500 yards.

2383. Was that done?—Yes.

2384. And the old weir taken down?—Yes.

2385. Does your evidence as to the rise of the water apply to the new weir or to the old one?—That of which I have spoken is the new weir.

2386. Then are the Commission to understand that no tide flows beyond your present weir?—The high water of ordinary neap-tide does not, but high-water spring-tide does flow over.

2387. How high beyond that does it flow?—We feel the spring-tide rise, that is to say, we feel the river swell up at the Glasgow Works, which is very nearly two miles above it, but there is no stream upwards, merely a swell of the river, occasioned by the slope of the surface of the water being lessened.

2388. Is the Rutherglen Harbour above or below the new weir?—Above.

2389. Then there is no admission to Rutherglen but by small vessels which can come through the bridges?—None; nor has there been since 1345. I would add, that the same navigation exists now that ever did to Rutherglen, with the single exception that at low-water the weir is a fixed barrier; at high-water there is the same depth above the weir that ever existed.

2390. Can the vessels in going to Rutherglen cross the weir?—At high water they can.

2391. Over the top of the weir at high water what depth would you have at the highest tide you have ever seen?—I cannot say positively, but my impression is, that in the highest tide there might be upwards of three feet.

2392. At that time what would be the depth of water below the weir?—12 or 13 feet.

2393. If there was no weir vessels drawing 12 or 13 feet water could go up to Rutherglen

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[*] See Appendix, p. 152.

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at high water?—They might, but the cause of this great depth below the weir has been the operations of the Clyde Trustees in dredging out.

2394. Might not the trustees dredge it above in the same manner if the weir were removed?—They might, on obtaining powers under an Act of Parliament; but the point where the weir has been placed is the upward limit of the field of their operations; but there are many very important considerations which must be regarded. In the first place, there are several very valuable factories that are above the weir which draw their water from the river. If the water were lowered, at low water they would be put to the inconvenience of not being able to draw water for their engines and purposes of their works, which forms the staple trade of Glasgow, during the time of low water.

2395. Is not the navigation in that point of view put to an inconvenience by not being free?—I am not aware of any advantage arising from the navigation. The navigation that existed to Rutherglen in the olden time, according to the evidence of the old men to whom I have alluded, existed in consequence of the bad state of the roads by land. At that time coals were brought into Glasgow in sacks on the backs of horses, and whenever it came on bad weather, the roads not being paved, the horses stuck in them. When the roads were afterwards improved the navigation ceased entirely, because, according to the evidence of one of these men, it was only a little further to drive coals into Glasgow from the coal hills after they were once put on the cart, than to drive them down to Rutherglen.

2396. Have not all these circumstances changed by there being good roads and improved navigation?—Yes, as regards the roads, but the navigation remains as it was.

2397. Are you aware where it is proposed to cross the Clyde by the route of the new railroad?—I am not; I have heard that it is to cross the Clyde near the Cranston Hill Water-works.

2398. That is to the eastward of the Cranston Hill Water-works?—Yes.

2399. How far?—I do not know.

2400. If the railroad should cross the Clyde anywhere to the eastward of that weir, would not the communication between the railroad and the river be stopped by the weir?—The weir is now proposed to be reconstructed about 140 yards above Hutchison's Bridge, and a lock or other work is to be put into it to connect the upper with the lower navigation. To the extent of communication that this lock will afford, the navigation will be opened.

2401. What objections are there to moving the weir a mile and a half up above Rutherglen?—The interest of several factories and the water-works. But we do not object to any position of the weir, provided it were put below the water-works.

2402. Have these manufacturers, whose interest you speak of, any Acts of Parliament securing to them the water from any particular part of the river?—The Clyde Trustees are bound to compensate them in the event of removing the weir. In the Clyde Navigation Act of 1840, it was provided that the weir should be removed to some point below the water-works; but, in order that these parties should not be a total barrier to the removal of the weir above them, it was provided that they shall be compensated in some manner.

2403. If the navigation was required from the weir up to Rutherglen, there is no objection further than the claim of the Water-works Company and private companies to compensation for loss?—Precisely.

2404. Then that compensation would require some means by which the water should be supplied?—Yes.

2405. Are you aware from your own knowledge from what distance above Dalmarnock the water might be brought by canal, independent of the river, to your water-works?—In 1839 I recommended the Directors to bring down a supply of water from Carmyle, about two or three miles above Dalmarnock. We brought a Bill into Parliament to obtain powers to do so, in 1840; we were met in the first place by objections on the part of the proprietors and coal-owners; we wanted to convey the water as cheaply as possible, either by a brick or stone culvert; they objected to this because they said it would send water down on their coal workings, and they required us to be responsible for the whole increase of water they might find in the mines after the works were executed. To meet that objection we proposed to convey the water by a cast-iron pipe, but that was not considered satisfactory, and the agent of the Duke of Hamilton wished that we should make a canal, which would be fit for navigation. The Water Company considered that so objectionable that they refused to accede to it. The Bill was lost.

2406. Did you form any estimate of the expense for which a sufficient supply of water could be brought from Carmyle to where you now are?—I think some where about 50,000*l.*

2407. Are you able to say whether the work could now be done for that estimate?—I think it could be done for less.

2408. Would that supply all the water that would be required for the town and these manufactories also?—I did not take the manufactories into calculation, but merely looked to ourselves.

2409. Is there anything to prevent the manufactories pumping up to a reservoir whatever quantity they might want out of the river, supposing it free?—Nothing beyond the expense.

2410. Are there any other objections to removing the weir?—There is the injury it would do to the public green, to the health and enjoyment of the population. The Glasgow Green is surrounded by parts of the town which are occupied by the poorer class of people. On fine Sundays they go upon the Green, to the number of several thousands. If you remove the weir further up the river than it is now intended to be, the sewerage of the town, containing all the waste of the manufactories, and all the warm water of some hundreds of steam-engines, will keep playing up and down and past the Green, and vitiate the air in the immediate neighbourhood of the river.

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2411. What is the rate of the ebb opposite there?—In summer and in low states of the tide you can scarcely observe any current going down. I have ascertained that the quantity discharged by the River Clyde in the lowest state of summer water does not exceed 100 cubic feet in a second.

2412. Is it not clear from your evidence, that if the weir was removed and the channel deepened above as it is below, that a volume of water equal to 9 feet in depth would sweep up and down every tide, and carry away any refuse of that kind?—That which goes up and down by the tide will be in summer principally the drainage of the town.

2413. Is it not more likely to be stagnated by a weir that stopped the ebb and flow than if it was cleared?—At present, in low states of the tide, the whole water that goes down is that which flows down from the higher grounds and passes over the weir; the water above is comparatively pure to what it is below. If you go down the river in a boat below the weir, where you are near the surface of the water, the smell is most offensive, as the water for some miles down consists mainly of the sewerage of the town.

2414. From your knowledge as an engineer, would not the flow up and down make the water purer than it is now?—I do not think so; it would not be such pure water.

2415. To what extent do you consider the rapidity of the river would be increased by removal of the weir?—I have found that since the Clyde has been opened up below the harbour by dredging and clearing away a contraction in the river that existed formerly below the Glasgow Bridge, that in our heaviest floods the Clyde has increased from four and a-half miles to about six miles per hour, near to the water-works. If the weir were removed, the river would, to some extent, deepen its channel above the point where the weir is now constructed; and in proportion to the extent of additional area acquired, the current of land-floods would be slower at the part so widened and deepened than under the same circumstances it would be at present, always supposing that the lower stages of the river are to remain in their present state; but in any part of the river above this deepened part where the channel might retain its present section, the removal of the weir and the deepening of the channel upwards would have a tendency to increase the current during land-floods. In heavy land-floods the tide has no influence on the surface of the river at the water-works. To the best of my recollection, aided by diagrams frequently made of the wave of floods, it does not produce any effect on floods of even 6 or 8 feet of elevation. If the weir were removed, and the lower stages of the river sufficiently widened and deepened to allow the wave of tide to affect the surface of the river at the water-works during heavy floods, to the extent of several feet, the current of the river, with a falling tide, would be so rapid as to be incompatible with its continuance in its present tortuous channel at and above these works, and much injury would ensue from the change of the channel of the Clyde to the owners of minerals near to that river. For some distance above Glasgow the valley of the Clyde rests on a bed of liquid mud, of from 40 to 60 feet in depth, covered with a crust of sand and gravel, only some feet thick; consequently, any attempt to confine the river to its present channel, with a current greatly increased in rapidity, would be almost endless labour.

2416. (*Capt. Washington.*) Can you state the mean annual discharge of the river Clyde—the discharge per second in the largest freshes, and also in its lowest state?—I have not yet calculated the mean annual discharge of the Clyde, but have caused observations to be made several times a-day of the height of the river, and I have tried the rapidity of the current at the different elevations of flood, in order to calculate the mean discharge. These observations have been taken for the last seven years. In the lowest state of the river, the quantity of water in the Clyde passing the Glasgow Water-works does not exceed 100 cubic feet per second, while a flood 18 feet in depth discharges about 35,000 cubic feet in the same time. The flood of February, 1831, rose 20 feet at the Cranston Hill Works, opposite to Rutherglen.

2417. Are you not aware that both the well-known engineers, Telford and Jardine, engineers to the Edinburgh Water-works, reported and gave it in evidence, "That if the bottom of the ford at Dalmarnock Bridge be secured, so that its present level remain undisturbed, the weir may be taken away at Glasgow Bridge, and the Clyde deepened between Dalmaruock Ford and that bridge for about 6 feet, without, in their opinion, doing any injury to the Glasgow Water-works?"—In May, 1825, Mr. Telford, as engineer for the Clyde trustees, stated to the Committee of the House of Commons, that if the bottom of the ford at Dalmamock Bridge be secured, so that its present level remain undisturbed, that the Clyde might be deepened 6 feet from the Broomielaw Bridge up to the south-east extremity of the public green; and that a part of the scheme for which the Bill then in Committee sought powers to execute was, that the weir at the Broomielaw Bridge should be maintained at the height it then was, and that the upper and lower navigations should be connected by a lock, passing through that weir. Mr. Jardine went further, for he said (always, it may be presumed, under the same conditions) that the deepening might be carried up to Dalmarnock Bridge; but it will be seen by the clause in the Act (*see* Appendix) that it was a part of the design that the works should "be conducted on such a plan as neither to raise nor lower the surface of the river Clyde at low water above the new bridge of Glasgow;" and from the evidence it will be seen that the deepening here referred to was merely the excavation of a channel about 30 or 40 feet wide in the bed of the river.

[*The Witness withdrew.*]

Adjourned till Wednesday, 2nd July.

Wednesday, July 2nd, 1845.

Present :—

Rear-Admiral BOWLES, C.B., in the Chair.

Captain Sir G. Bremer, K.C.B.	Mr. Godson, M.P.
Mr. Hume, M.P.	Mr. A. Chapman, M.P.
Captain Beaufort, R.N.	Captain Washington, R.N.

Capt. John Fisher, R.N., sworn and examined.

[*Capt. Bullock's Chart of the River Thames, on the scale of* 20 *inches to the statute mile, made in* 1831, *was laid on the table.*]

2418. (*Chairman.*) What is your profession and place of residence?—I am a Commander in the Royal Navy, principal Harbour Master of the Port of London, and reside at St. Katherine's.

2419. How long have you been acquainted with the River Thames?—I have held the situation of harbour master 26 years.

2420. Are you aware of any obstacle to the navigation from shoals or hards in the bed of the river that might be removed with advantage?—A considerable shoal was formed about 200 feet below London Bridge, 75 feet of which was dry at spring tide; other shoals were created by the fall of water from the bridge; there were 10 or 11 feet water from the bridge; the bridge formed such a dam that it cleared every thing away.

2421. You speak of the old London Bridge?—Yes; where it was dry ground I have made a depth of 11 feet water, which is done by the Corporation of London, assisted by the Trinity House. We have generally lighters at work in the centre of the river, in order to make it from 13 to 15 feet. When we find any little accumulation we clear it away immediately; but since the steam-boats have been running at low water it has preserved the channel; in fact, the navigable channel of the river has rather increased from the action of the steam-boats going over at low water. It is the invariable practice, when we want to clear away a shoal, to go on the lower part of it, and work up, because any loose sediment is carried away by the ebb tide, and if there is any deposit the Trinity House lighters generally take it up. I am now at work on the Whiting shoal, which is in Limehouse Reach.

2422. Having removed that bank which formed at old London Bridge, you consider there are no further obstacles until you get to Limehouse Reach; where then do you consider is the next great obstruction below Limehouse Reach?—The next considerable shoal is what is called Ham Shelf, at Woolwich; that is a nuisance, particularly to Her Majesty's ships and vessels bound up into the docks and pools, that come up to Woolwich. Government has laid out a great deal of money in clearing that Reach, but, I believe, with very little effect, from the set of the tide. There is a point called Hookness which sets the tide over to Woolwich Dockyard, and in the slack tide the mud deposits and forms a bank. As fast as they take it away it forms again. Mr. Walker, in his Report of 1842, recommends with respect to the shoal, to cut off Hookness in order to direct the tide down in the centre of the river.

2423. (Mr. *Hume.*) A letter was addressed by you on the 11th of January, 1842, to the Thames Navigation and Port of London Committee, in which you state that you perfectly agree with Mr. James Walker as to the recommendations he offers to the Committee?—I do.

2424. What are the principal recommendations given by Mr. Walker in that Report?—Mr. Walker's plan was to lay down a straight embankment throughout the river without any projection, in order that the tide should have more effect upon the shore in preserving the depth of water.

2425. Does he not recommend that any projecting points should be cut off, and any hollows filled, in order to give one uniform channel sloping from each side to be the deepest in the centre?—Yes; I perfectly agree with him upon that point.

2426. Did you examine the map which he gives of the width at different parts which he proposes to maintain?—I did.

2427. Captain Bullock appears to have concurred also in that Report?—Yes; I attended that survey, and approved of the lines which I considered to be the best from my practical knowledge of the river.

2428. Mr. Walker says in one part of the Report that it would be discreditable that the irregularities in the present bottom of the river above London Bridge should be suffered to remain when the immense importance of the navigation is considered. Could the irregularities you first spoke of be in some degree removed?—I am aware of irregularities above bridge; but my duties are strictly confined to below bridge.

2429. You recommended to the Navigation Committee that they should deepen the river from London Bridge downwards in that regular form, making the depth part of the current in the centre of the river throughout?—I did.

2430. Why have you not carried that out, and begun your excavations agreeably to that plan?—I am not aware: it is under the direction of the Navigation Committee. I have occasionally pointed out those difficulties, and, in fact, recommended them to be removed.

2431. In that Report it is stated,—"Above London Bridge, gravel and sand for repairing roads, making foundations, and other purposes, are raised by permission of the Lord Mayor, as Conservator of the Thames; and individuals thus authorised take such materials wherever the quality suits them, without sufficient regard to the navigation." To what is allusion prin-

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cipally made?—Mr. Walker, when he made that report, considered it ought to be under proper authorities to point out the situation where those people were to work in the Channel. They had been in the habit of working at different places, making holes; and in some places there would be 5 or 6 feet of water, and at other places not one foot.

2432. What places do you allude to?—I mean above London Bridge.

2433. Under what authority were they allowed so to do?—By the Lord Mayor, under the direction of the water bailiff.

2434. Does the Lord Mayor give permission to parties to take sand and gravel where they please, without directing them to take it from the shallowest part of the river?—It was so formerly, but is not so at present. It is under the direction of the water bailiff.

2435. Has any alteration been made in that respect since 1842, when that Report was made?—There is considerably more water in certain places, but they have not carried it up through the Channel.

2436. Are those who are allowed to dig below under any rule or regulation as to the place from which they are to take it, so as to make it uniform?—It is under the direction of the water bailiff to direct them where to work.

2437. Does the water bailiff carry that out?—I am below bridge; but I believe he is very particular.

2438. (*Capt. Beaufort.*) Is the water bailiff a man who understands what ought to be done, and what ought not to be done?—He understands it perfectly.

2439. (Mr. *Hume.*) It is stated in this report,—"A main object is to take means for removing those encroachments by an approximation to a uniform width and depth." Have means been taken to have an uniform width and depth by all the excavations that have been made?—No.

2440. Why have they not?—That is a question I cannot answer.

2441. Do you see any difficulty in that being done, if the plan pointed out here was carried out under proper authority?—I think not, but it would be done at a considerable expense.

2442. Is it your opinion that the river might be widened from any part upwards, by adopting the course which is stated in this report of Mr. Walker?—I think not: I think there is no necessity for giving it greater width below London Bridge; there is quite sufficient width for the passage below the bridge.

2443. My question is, whether you see any difficulty in the widening being made regular from each side to be the deepest in the centre, as pointed out by Mr. Walker?—There is no difficulty in doing it; but it would certainly affect a great many interests in water-side premises.

2444. Does not Mr. Walker recommend that all those on each side should be called on to pile and defend their premises, so that you might secure the depth in the centre of the stream?—Yes.

2445. If that was done, would not it very much improve the harbour and ship-way?—No doubt of it. It may be necessary to observe, that they have got a plan of running out jetties, barges, and craft, from different landing places; most of them are in private hands; and two-thirds of the time those barges are grounded. The consequence is, that it stops the free current of the water, both on the ebb and the flood, and there is an accumulation on the shore; not in the middle of the river, but on the banks.

2446. Does not the Navigation Committee recommend the removal of all these nuisances, and object to the manner in which license has been irregularly given?—Yes.

2447. Have any steps been taken since that Report pointed out the absolute necessity of removing those jetties, to prevent the accumulations which have taken place there?—No; some have been removed, but the most objectionable still remain.

2448. Where?—There is one at Greenwich, which runs out from the Garden Stairs. The parties have taken possession of the public stairs; they prevent the watermen coming in, and obstruct them in their passage, besides stopping the circulation of the free current of the tide.

2449. Do you concur in Mr. Walker's opinion, that every jetty interfering with the channel of the water tends to injure the harbour by interrupting the current, and introducing eddies?—It does.

2450. Ought not every one of those jetties to be removed if you wish to improve the river effectually?—Yes; but for the benefit of the public, I think there might be some jetties at different points put out under a proper authority, and not in the hands of private parties, if those jetties were erected on proper principles on open piles.

2451. If jetties sufficient for public accommodation upon open piles were raised, would not that prevent the accumulation which is now going on at those several boat jetties?—Yes.

2452. Has any representation been made by you, or any of the harbour-masters, since this Report in 1842, in which you entirely concur?—No; I have repeatedly, in conversation with them, when erecting jetties, recommended them to pile it down. At Greenwich, the pier that I have complained of was constructed; I removed it three times, considering it was a nuisance. The Lord Mayor (Alderman Humphrey) sent me an order, which I am bound to obey, to let it remain, and there has been a constant state of warfare respecting it.

2453. You find that the change of Lord Mayors, and the applications of different parties, produces uncertainty as to orders, and renders it difficult to act on any one system?—No doubt of it. I conceive that if there was a Commission of Nautical Men to be constantly at work, elder brethren of the Trinity House or Lords of the Admiralty, those views would be carried out, and the river would be considerably improved by having people who understood it.

2454. Do you mean to say that if there was one authority for carrying out the plans recommended by Mr. Walker, Captain Bullock, and yourself, the whole of the river, from London

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Bridge down to Woolwich, might be cleared in the way pointed out in this Report?—Yes; and much more expeditiously.

2455. Can you state why the Whiting and other shoals have been allowed to remain so long to interfere with the navigation?—I am not aware; I found the Whiting Shoal there, but since the docks have been made, a larger class of ships come up the river. Formerly there were no impediments, but now it is necessary there should be depth of water to give them accommodation.

2456. Do you recollect the state in which the navigation was before the old London Bridge was taken down?—Yes.

2457. What has been the effect with regard to the scour of the water since the new bridge was built?—In the lower part off London Bridge below, I find very little difference at all. The old London Bridge acted as a dam; it has prevented the body of water from going up. We have had, certainly, rather higher and lower tides than we used to have formerly. In spring tides it is occasionally three feet above the Trinity standard higher than it used to be.

2458. Do you mean that the tide has risen higher than it was before?—I do not say generally; we have had that before.

2459. It is stated in this Report, that the increase of the scour since the removal of London Bridge, as well as the action of the paddle wheels of the steamers, have tended much to deepen the channel from London Bridge downwards?—It has.

2460. Then the river is deeper?—It is deeper in the channel.

2461. What would be the expense of commencing at London Bridge, to carry out Mr. Walker's plan regularly from each side to the centre, and making the river like a canal, as he reports?—I cannot exactly agree with Mr. Walker upon that point. By making a depth of water for steam boats, it will injure the large wharfs on each side; it will take away the support of the foundation by carrying it to such a length as that.

2462. Does not Mr. Walker recommend that pilings should be placed along by the whole of the banks on each side, so that the property should be so protected?—Yes.

2463. If that were done, could not the navigation be improved?—Yes; it would assist the foundation walls, and prevent their tumbling, but I think there would be great difficulty in getting parties to go to such an expense. It is practicable.

2464. Are you allowed to sell the gravel which you raise?—We can dispose of it for concrete for railroads, or any other purpose; we are not allowed to ballast ships from the excavations.

2465. Do you raise any mud?—There is hardly any mud to be found now; the steam-boats wash it all away.

2466. If you were allowed to sell the shingle for ballast to whoever would take it, would that pay the expense of the dredging?—No, but it would assist in paying it.

2467. To what extent would it assist?—I cannot say; it depends upon the quantity; but, taking an average, perhaps one-fourth.

2468. (*Capt. Beaufort.*) How much will a vessel raise in a-day?—On the Whiting Shoal we have been raising 100 tons per day.

2469. (Mr. *Hume.*) Have you had occasion to blow it up, or has it been by ordinary dredging?—All this hard rocky stuff, when the engine gets obstructed from lifting it, I blow up by gunpowder.

2470. What kind of materials have you brought up?—There is a sample of it here; it resembles plum-pudding stone, or a conglomerate of gravel, oyster and other shells, apparently being a calcareous cement. This has been in a loose state; it is probably the action of a mineral spring, which has come up through the water, that hardens it.

2471. Has that not been the most difficult shoal of the river to remove?—Yes.

2472. In other parts of the river where there is shingle and earth, what quantity could you raise per day with one vessel?—The Trinity House with their steam-engine has raised 120 tons in 35 minutes.

2473. Have you not employed steam dredging-boats yourself?—I have one now.

2474. How many horse power is that dredging-boat?—About 20.

2475. Have you employed that machine in any other place but the Whiting Shoal?—No.

2476. Are you able, from what you have seen, to state what quantity a dredging-machine of 20-horse power would bring up of shingle in the course of a day?—The Trinity House could give more correct returns than I am able to do.

2477. Suppose these two engines were placed at your disposal to be continuously employed to clear out the river, as recommended by Mr. Walker, do you see any difficulty in that being done?—It could be done no doubt in the course of time.

2478. Supposing two lighters were placed under your charge of the same power as the Trinity lighters, do you consider that you could carry out the recommendations of Mr. Walker and others respecting the river from London Bridge downwards?—I cannot positively say that it could be done, but I think it might.

2479. If these lighters had been employed during these last 20 years in that work, do you not consider that the river might have been cleared down to Woolwich by this time?—I do not think it possible, taking the rock and all together.

2480. Is there rock in any other part of the river that you know?—At different parts of the river there is concrete formed in-shore, and there is a good deal below Blackwall. When we get to the gravel, after getting down a certain depth, we get into a harder material; but the greatest difficulty is the clay. There is a substance of clay under the gravel which hardly any engine will penetrate; when a powerful engine belonging to the Trinity House has been at work, I have seen the end of the iron buckets rolled up.

2481. Do you see any objection, but that of expense, to clearing the river agreeable to the

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plan in which you concur with Mr. Walker?—None at all; the expense is the only objection.

2482. Are you able to give any idea of what the expense would be in employing two dredging machines per day and selling the material you take up?—I am not at all prepared to state that.

2483. With respect to the dredging-machines of the Trinity House at work in those parts under your charge, what rule is laid down respecting their operations?—Wherever there are any banks the Trinity give directions for their ruler to work upon them, and to work the part which is fit for ballast.

2484. Who removes such parts as clay which are not fit for ballast?—I cannot state; the Trinity House do not.

2485. Are we to understand that the Trinity House do not take up mud which lies in the middle of the river?—Certainly not.

2486. Does not mud impede the navigation as well as shingle?—At present we have got no mud.

2487. (*Capt. Beaufort.*) You have peat and clay instead of mud?—The principal part we have to contend with is loose gravel, which forms a sort of concrete.

2488. (Mr. *Hume.*) Have you not just stated there is a mud point opposite Woolwich?—It is the point which projects from Woolwich; it is not mud, but hard gravel.

2489. According to your statement, there is no impediment now to clearing the river of a uniform depth from London Bridge down to Woolwich, except the want of means?—I am confident, with the machinery we have now got, and the means of exploding by gunpowder, there is no difficulty except the want of funds to carry it on.

2490. You are not able to state what that would amount to?—I am not.

2491. Could you sell more gravel, if you had it, for concrete and other purposes?—I am not aware that we could; it depends on the work that is going on. The principal concrete that we get up that has been sold for a railway is raised above bridge—from Westminster Bridge down to London Bridge.

2492. There is no difficulty, then, if a proper plan were followed, in having a regular channel deep in the centre from Westminster Bridge down to London Bridge?—None.

2493. But there being no system followed, it is irregular, as you now state?—The parties at work for the concrete go and dig up the stuff which suits their purpose; they will not keep to going through the channel; they take the stuff that is got up the easiest.

2494. Does not that injure the navigation instead of tending to make a uniform channel?—Yes.

2495. Is it not contrary to what Mr. Walker recommends, as to the deepening and equalizing the bed of the river throughout?—Certainly.

2496. Then all these orders are against the opinion of Mr. Walker, and that which you yourself have given?—This is done above bridge; I direct them below. My object is to keep a good channel for the ships in a fair way; but above bridge the water-bailiff, I know, has ordered them to clear the channel from the middle arch of one bridge down to the other; and, as far as I know, I rather think he attends to the working of those steamers.

2497. (*Chairman.*) Have you any authority from the water-bailiff?—No. The water-bailiff is called a sub-conservator of the river Thames: he is appointed by an old City of London charter; I am appointed by Act of Parliament.

2498. (Mr. *Hume.*) In this Report, with which you concur, it is stated, "By a grant or charter from Charles the Second the Trinity House Corporation were authorized to receive certain fines and contributions, to be applied in removing shelves and annoyances in the river; but these fines having long since been other ways appropriated, and the Trinity being therefore left without funds available for these purposes, the grant has, I believe, been in this respect a blank letter;" do you know to what that refers?—I do not.

2499. (Mr. *A. Chapman.*) Are you aware that, whenever any shoal comes under your notice raising a difficulty to navigation, it is customary to apply to the Trinity House for them to set their ballast-lighters to work to take ballast from that shoal?—Yes; I have made application to the Trinity House when those shelves have got up, and I have found no difficulty whatever unless it does not answer for ballast.

2500. So long as it answered for the purpose of supplying ships with ballast, and the ships were willing to take it, did those lighters continue to take the impediment away from the river?—When I have represented it to the Trinity House, the Trinity House have immediately set their lighters to work upon it; but if they found the material on the shoals not fit for ballast they have discontinued it.

2501. (*Capt. Beaufort.*) Is it not all fit for ballast if there is no mud?—There is very little but what is fit for ballast now; but there are some parts so hard that it would not pay the men (who get so much per day) for getting it up.

2502. (*Chairman.*) In point of fact, are there now any such banks or obstructions in the river which are not removed because the Trinity House lighters do not work upon them?—They have tried to work upon the Whiting Shoal, and in consequence of the damage their machine received they left off. No machine could work upon that unless it was removed by gunpowder. I am going to apply for one of the Trinity House engines to follow this up, and I have very little doubt I shall have the assistance I require from the Trinity House. We frequently have some of the Trinity House lighters at work, taking up the Whiting Shoal, besides our steam-engine; they take up on an average about 100 tons daily.

2503. (Mr. *Hume.*) Will the Trinity House Lighters take any material from the bed of the river unless the material can be sold for ballast?—Certainly not.

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2504. This Report of 1842 states that there were "several wrecked vessels sunk in the navigable channel of the river;" have they been removed?—I have blown three or four of them up myself.

2505. Are they all removed now?—No; we have got four or five more within the last twelvemonth.

2506. Whereabouts are they sunk?—From Northfleet Hope down to Sea Reach.

2507. Are they in deep water?—One vessel I raised last year, the Atlas. She sunk in 10 fathom water. In consequence of the obstruction to the tide in Higham Bight, there was an embankment of sand formed round her of about 50 feet; and I am confident if that vessel had been allowed to remain there, the bank would have extended further over on the Essex shore, and in the course of time would have been an obstruction.

2508. Why were not a couple of engines put to remove the sand?—I moved the vessel up, and since that the sand has all dispersed.

2509. The wreck was the means of collecting the sand?—Yes.

2510. What prevents you removing any other wrecked vessel that remains now?—Nothing at all. The City of London are now entering into a contract for removing the remainder that are sunk.

2511. Where are these vessels wrecked?—There are two barges in Northfleet Hope, one in Higham Bight, one off Hope Point, and two vessels in Sea Reach, which are laden with Macadamized stone.

2512. (*Capt. Washington.*) Are they not on the edge of the Bligh Sand, near the same spot that the French steamer-of-war, carrying back the Duc de Nemours, grounded in 1843?—Yes.

2513. What do you think was the probable cause of those vessels being wrecked?—I believe by collision with colliers.

2514. (*Chairman.*) Whenever vessels are sunk, are immediate measures taken by the corporation or any other authority to remove them?—We generally send to the under-writers and owners to remove them; and if they do not, after a certain time, the corporation of London take them in hand themselves.

2515. What do you call a certain time?—The last one I raised had been there 18 months.

2516. There are no immediate measures?—No; it depends on the situation where the vessel is sunk; if it is sunk in the centre of the river, where the navigation of the river is obstructed, immediate measures are taken to raise it, otherwise they are in no hurry about it.

2517. Who is the proper authority to give orders for weighing vessels that are sunk?—The Lord Mayor, as the conservator of the River Thames.

2518. (Mr. *Hume.*) Are orders given immediately to remove a vessel that is sunk?—No; it depends on the situation the vessel is in. If it forms a material obstruction, measures are immediately taken for its removal.

2519. What is the longest time you have allowed a wreck to remain sunk?—The Grampus lay 20 years; but that was wrecked long before my time.

2520. Where did she sink?—She was wrecked on Barking Shelf.

2521. (*Chairman.*) Does that Shelf exist now?—Yes; although it has been considerably reduced by the Trinity lighters working on it for ballast.

2522. (*Capt. Washington.*) Did not that very shoal stop the Royal Yacht, with Her Majesty on board on her return from Scotland, from coming up to Woolwich, for two hours last year?—Probably; but I was not aware of it.

2523. (Mr. *Hume.*) You say that a considerable portion of the Barking Shelf has been removed. What is it that remains; is it clay and peat, which existed in 1842?—It is composed of silt and gravel.

2524. Why is not that removed?—I am not aware.

2525. Could it be removed?—It could be removed, but at a great expense; it has, however, been gradually reduced by the Trinity House.

2526. But the Trinity House only take gravel, you state?—That stuff answers very well. I have seen 30 or 40 of those dredging vessels lying there in the course of a tide.

2527. It is stated that in Cold Harbour a point of sand extending from the north shore to the middle of the river, eight feet deep, existed in 1842; does that exist now?—Yes.

2528. Why has not that been removed?—I am not aware, but I think the reason is because there is sufficient channel on the east side of it towards the Kentish shore.

2529. Would not the removal of that make the channel better?—It would make it wider; but we consider we have sufficient width without that.

2530. It is said there is a shoal of sand in Erith Reach, 200 yards above Cold Harbour Shoal, with a depth of six feet; does that still remain?—Yes.

2531. Why is not that removed?—I do not know; but I believe for the same reason that I mentioned before, that there is a sufficient depth of water on each side of it.

2532. Do you know where Dagenham Shelf is?—Yes.

2533. It is stated in this Report that that extends from the north shore, nearly half way across the river, with eight feet water. Does that continue?—I do not recollect any shoal of that kind. I think it is pretty well gone away, because there is sufficient depth of water for vessels to go of any draught down to there.

2534. Do you know at Bugsby's Hole there is "a shoal water reach in places only eight to nine feet, with some shelves and small shoals, having only six to seven feet;" does that remain?—There is a shoal there which runs from the Essex shore right down; but on the Kent shore the channel lies. I put 75 sail of colliers in that section, and since the colliers have lain there it has increased the depth of water, I may say, four or five feet.

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2535. Did not Mr. Walker contemplate the removal of that so as to give a uniform channel?—Mr. Walker's plan was to make a uniform channel throughout. There is no doubt all those shoals, if they could be removed, would be very beneficial.

2536. It is stated that opposite the River Lea the shore gained from the north side only eight feet; does that still continue?—There is quite sufficient water coming round Blackwall Point. Some part of it is hard material.

2537. In the middle of the river?—It does not extend; in the middle of the river there is quite sufficient water.

2538. In 1842 it is stated that the middle grounds in the centre of the river, between Blackwall and Greenwich, had upon them nine to ten feet; have these been taken away?—The middle grounds stand at present like a sugar loaf; there is no breadth to it. The Trinity House lighters have been working upon it, and they have made 14 or 15 feet all round that; the top of it is deepening. The shoal has been reduced.

2539. Have they been dredging all round it?—Yes.

2540. Could not that be blown up, as you have done Whiting Reach?—Yes; but it is a loose kind of material.

2541. If it is loose, why did not the dredging machines take it from the middle of the river?—I am not aware; it is gradually reducing. There is a sufficient channel upon the east side of that, or upon the west side, for ships to pass. I have never seen a vessel grounded on it for years.

2542. (*Chairman.*) What is the nature of the shoal you are speaking of?—It is hard gravel and pebbles.

2543. (*Capt. Beaufort.*) Petrified?—No it is not petrified, but it is very hard.

2544. (Mr. *Hume.*) You are aware that this plan of Mr. Walker's recommends that embankments should be made in low places, and that the materials should be taken out of the river to fill up the edges of those embankments, keeping the width pointed out in his plan; have any of these embankments whatever been made?—Several.

2545. Whereabouts?—In the upper Pool there are several brought out, according to the line of Mr. Walker.

2546. Have the materials from the bed of the river been put in there to fill up behind?—They have not. They have got permission from the Navigation Committee to carry out this line according to Mr. Walker's plan, and they filled it up in any way they could.

2547. Would not that be an easy mode of disposing of clay and stuff that is not fit for ballast?—There is very little doubt that it would, but we do not interfere with that. I believe a good deal of material that comes out of the river is thrown upon that part.

2548. It is stated as an objection the throwing in ashes and materials from the city; have any orders been given to prevent ashes being thrown in?—Every one that is found throwing them in is liable to a penalty; I have seen very little of it; it might be done in the lowest part, but in the upper part the ashes are too valuable to throw away. From Westminster upwards, I do not believe there is an atom thrown into the river.

2549. Are the Board to understand from all your experience, that there would be no difficulty in making the river Thames a deep channel of uniform depth from London Bridge downwards, provided the expense necessary for that purpose was provided?—I think no difficulty; with the machinery we have now got we can do anything.

2550. Do we understand that the Lord Mayor is not allowed to take up any gravel and sell it, below the bed of the river, to any vessel?—Not for ballast.

2551. If they were allowed to sell the ballast, would they continue the work of dredging?—They would continue the work of dredging; but I cannot say how they would dispose of it. With the aid of gunpowder, &c., and the galvanic battery, it is proved that anything can be knocked away. With 45 lbs. of gunpowder I have tried under a shoal, and I have tried it on the top; and laying it on the top, it is generally all broken up to 30 or 40 feet in diameter.

2552. (*Capt. Washington.*) You have referred to the Trinity standard; will you state who placed those standards, and where they are placed?—The Trinity House placed them; every dock has got the mark of the Trinity standard; from Greenwich up to London Bridge we have stones to put down; and at several points.

2553. Do you state that you placed them?—The Trinity House placed the marks upon the Bridges, but on the shores I have placed them and stones in the river with the Trinity standard marked upon them.

2554. Are these standards all placed at the same level?—They are.

2555. By whom?—By Mr. Elmes, Surveyor of the Port of London.

2556. Are they kept clean so as to be always visible, and referable to in case of need?—They are.

2557. Have you seen these marks yourself at different bridges?—I have; several of them have been out from the washing of the steamers, and we have taken the levels again and replaced them upon the proper level.

2558. Is not the level cut or let into the stone?—There are marks on the bridges. We take the level of the stones, and these stones are let into the ground.

2559. Will you describe the nature of the standard; is it a metal level let into the stone, or is it scored in the face of the stone, or painted?—It is granite stone cut out with a chisel.

2560. (*Capt. Beaufort.*) You said, alluding to Woolwich, that the mud still accumulates in front of the dock-yard?—It does.

2561. Can you suggest any means of keeping the front of the dock-yard clear?—There is very little doubt if it was taken away it would be all the better, but Mr. Walker says in his report, that unless the point on the Essex shore is cut off, as fast as you take it away it will accumulate again. It has been worked constantly; I believe it has cost Government 1000*l.* at different times, or more; and in two or three years it has got as bad as it was before.

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2562. How much of that point would be cut off?—It is marked in the plan.

2563. You agree with Mr. Walker?—Perfectly; it will make a more uniform set of the tide.

2564. With respect to the shingle for ballast; when there is more raised than can be disposed of, is there any flat, covered at high water, on which you can deposit it?—It may be deposited for different purposes; we deposit a great deal of mud out of the Docks; we throw it down on the embankment at the Isle of Dogs and other places to keep up the embankment.

2565. And there is sufficient space to lay out any quantity of shingle that might be raised out of the shoals?—Yes. Mr. Cubitt is going to carry an extension of the wharf from Greenwich Ferry; he has taken a great deal of the deposit of the river from that place to fill up.

2566. (*Chairman.*) Will you state to the Commission what general improvements you would recommend in the river?—I recommend Mr. Walker's plan of a regular line of embankment and removal of the shoals. As far as regards the moorings, they are perfectly complete; the colliers were formerly moored at their own anchors, and constantly breaking adrift. I have laid down stones of 11 and 12 tons, and embedded them 12 feet, and they keep their station in the channel, and a wide water way of 300 feet through the Thames is preserved. There is another improvement I should point out. Formerly I had no power below Blackwall; I have got the power now; and instead of having that glut of colliers in the upper part, I have got sections between London and Gravesend. When they come to Gravesend they are ordered to the different stations, and as vacancies occur orders are sent down from London for a number of colliers to fill up those vacancies. I think last January I had 900 sail of colliers between Gravesend and London Bridge.

2567. Do you find in practice any difficulty or delay arise from part of the duty of carrying away the shoals of the river devolving on you and part on the Trinity House?—Yes; at Woolwich Reach they are obliged to wait till there is sufficient water to go over Ham Shelf, I have known steamers wait an hour and a half, or two hours, to go over that.

2568. What do you consider a sufficient depth?—14 feet.

2569. You mean it is unnecessary expense to work below 15 feet?—Yes; below that Reach and above it we have 16 to 20 feet water; off the lower part of Deptford upwards of 20 feet.

2570. (Mr. *Hume.*) You have stated that Government have been at considerable expense about Woolwich; do you continue of opinion that if Hookness was rounded off, as stated by Mr. Walker, that mud bank would be much lessened, and perhaps swept away?—There is not the least doubt of it.

2571. Would not the cutting of that be less expense than the Government are at yearly in attempting to keep Woolwich clear?—There is no doubt of that. They may go to what expense they like, and they would not keep Woolwich clear, except that point was cut off. Government have been at considerable expense, and for years they have had the work going on, and as fast as they take it it gets bad again.

2572. (*Capt. Beaufort.*) You were speaking of the pier that is run out at Greenwich. There was a straight wharf of stone just above the Hospital which tumbled in; might not that have been kept sufficiently clear for the use of steamers by a judicious dredging in front of it?—That, in my opinion, would have been quite sufficient space for steamers, if it had not fallen in.

2573. Could it have been kept clear at low water by dredging alongside of it?—It could be done; but I think it would affect the foundations of the wharf.

2574. By judicious dredging on the hollow side of the river, can deep water be kept sufficient for all those steamers that go up and down the river?—I think not; I think it would fill up almost as fast as you take it down; and, again, where you have got a long pier like that, there is a rise and fall of tide of 18 feet. By having a barge outside of the pier, from the rise and fall of water the barge rises and falls with the tide, and, of course, it is more convenient and safe for the passengers to land from that, and the steamers to come alongside. I do not think any steam wharf or pier could do without something of that kind. At Billingsgate they have got a thing of this sort, and we do not find it any inconvenience, and fish-boats come alongside, and they have ladders at low water from that to the market.

2575. Is there any deep water alongside that iron wharf at Blackwall?—They have got barges there; but that is no obstruction whatever to the river.

2576. Why cannot wharfs be kept sufficiently deep for those steamers to go alongside?—There is no doubt of it, if they have depth of water.

2577. If the water can be kept sufficiently clear and deep on the concave side of the river at Blackwall, why cannot it be sufficiently deep and clear at Greenwich?—By going to expense it could be done. There would be no difficulty in it; but it would be attended with great danger, unless they had a barge alongside for the safety of the passengers landing. I may mention with regard to those piers running out, I agree with Mr. Walker, as to having a regular and uniform frontage for the river.

2578. You still suggest the propriety of having piers or open piles sticking out in the river?—I say where the public require it, and for their accommodation it ought to be done on piles, but on no other principle; because the piles will allow a free circulation of the current ebb and flow, and prevent accumulation.

2579. If the water is sufficiently deep, and the wharfs sufficiently long for the steamers to go alongside of them fore and aft, what objection is there as to the convenience of the public in that respect?—There would be no occasion to put any projection out if that was the case.

[*The Witness withdrew.*]

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2580. (*Chairman.*) You are a Vice-President of the Institution of Civil Engineers?—Yes.

2581. How many years have you been an engineer?—Upwards of 40 years.

2582. What tidal rivers and harbours have you examined and reported upon?—I have examined in a professional way, or reported upon the following; viz.—

Aberdeen Harbour,
Aberystwith Harbour,
Arbroath Harbour,
Ballyshannon Harbour,
Bute Ship Canal,
Ballyteig Lough,
Berwick Harbour,
Belfast Harbour,
Birkenhead Docks,
Clyde Navigation,
Dover Harbour,
Dublin Harbour,
Exeter Navigation,
Folkstone Harbour,
Falmouth Harbour,
Faversham Harbour,
Grangemouth Harbour
Hayle Harbour,
Harburg Harbour,
Hastings Harbour,
Harwich Harbour,
Humber River,
Kingstown Harbour,
Leith Harbour,
Lowestoft Harbour,
Langstone Harbour,
Loughs Swilly and Foyle,
Mulloghmore Harbour,
Mersey River,
Medway Navigation,
Newhaven Harbour,
Newry Navigation,
Rye Harbour,
Southwold Harbour,
Swansea Harbour,
Shannon Navigation,
Severn Navigation,
Sunderland Harbour,
Southampton Docks,
Tees Navigation,
Tyne River.
Wisbeach River,
Wyre Harbour,
Weymouth Harbour,
Waterford Harbour,
Wexford Harbour,
Welland Navigation,
Yarmouth Harbour,
And some others.

2583. In the course of your experience, have you been enabled to lay down any principle which is generally applicable to the improvement of tidal rivers?—I know of no general rule applicable to tidal rivers. Every case must be considered under its own circumstances.

2584. What are the chief obstructions to the propagation of the tide which are generally found to exist?—Crookedness of channel, unevenness of depth, and varieties of composition of the bottom and sides.

2585. Explain in what way these obstructions operate?—By causing eddies, sand or mud banks and deposits, and in a continual tendency to increase the evils.

2586. How can such obstructions be most effectually removed?—By a variety of modes, according to the circumstances of the case, *videlicet*, groining, wharfing, embanking, dredging, scouring, &c. &c.

2587. Are you of opinion that depths in rivers and their powers of scouring are chiefly due to the volume of water brought down in the freshes, or to tidal waters?—Chiefly to the tides as far up as the neap tides reach, and above that point principally to the freshes.

2588. Is there more to fear for our river harbours from the detritus brought down by the stream, or to silt carried into them from the sea?—Generally speaking, to silt brought in from the sea.

2589. Can you state any instances in which works designed in conformity with the principles you have laid down, have been productive of beneficial effects?—In the Clyde, at Yarmouth, Newhaven, Faversham, the upper tideway of the Severn, and many other places.

2590. Have you acted in every case upon the same principle?—No.

2591. Can you state any instances in which works designed in conformity with the principle or principles you have laid down have been productive of beneficial effects?—Yes.

2592. (Mr. *Hume.*) You are satisfied that in all these harbours great benefit has resulted from the application of art to assist nature?—Yes; but there are some cases in which nature beats all our art.

2593. (Mr. *Godson.*) You are, I believe, the engineer for the Severn Improvement Navigation?—I am.

2594. Have you proceeded to carry the operations into effect in that river?—Yes; we improved the Severn on two different principles; first, in the tideway as a tidal river, we improved it by contracting where it is too wide by embankments, by fascines, and other substances, and by dredging it where it is too shallow; that is, making it as much as possible by art of a uniform width and a uniform depth to ensure a perfect navigation, and which is succeeding to the utmost extent of my expectations. The other portion of the Severn, after the tide ceases, is improved by making the river into different levels or ponds, and connecting them by means of locks and weirs, so as to take off all the flood waters over the weirs and pass all the navigation through the locks.

2595. How many weirs have you erected on the Severn?—Four.

2596. By means of those four weirs, how many miles of navigable river have you now been able to obtain?—We have obtained a constant and uniform depth of six feet of water and upwards for nearly 20 miles, where formerly in places there frequently was not above eighteen or twenty inches for many months, and the navigation entirely at a stop; and we are now obtaining the same improved depth of water for nearly 30 miles in the tideway above Gloucester, by making a uniform breadth and depth of channel by the means I have stated. That is now nearly completed.

2597. Taking the whole together, in consequence of the four locks out of the tideway, and by fascines in the tideway, what is the whole length of your improvements in the Severn?—Upwards of 40 miles.

2598. Is it your intention to put any more weirs in the Severn, or are those sufficient?—Those are all we shall put under the present Act.

2599. Have you heard of the attempt to cross the Severn at a place named Hock Crib?—I have.

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2600. Would it or would it not be detrimental to that navigation to permit a bridge to be put over the river anywhere there?—If I were instructed to improve the navigation of the Severn for sea-going vessels, I should make a ship canal across the isthmus at Hock Crib and Framilode, for the purpose of obtaining a navigation, with double stop-locks at both ends of that cut. That would be a portion of the works I should propose for improving the Severn, leaving the river to go in its present channel round by Newnham; but combined with such cut and locks, I should embank off and reclaim many thousand acres of land on the Nooze sands, just below, in order to make a proper channel below for vessels to come up the same cut. That would both gain land and improve the navigation, and also improve the river above; but a cut across the isthmus, and with locks in it, must, I think, whatever be done, form a portion of the works for the improvement of the Severn navigation.

2601. Would that be quite independent of bridges?—So far that would have nothing to do with bridges, except the bridges of the roads which cross into the island; but, as an engineer, I should explain that I offered no objection to their making the cut, provided they made proper works, and kept them up at their own cost. It does not necessarily follow that the tide should be allowed to flow up to Gloucester, in order to improve the Severn, even in the best manner, because there are two or three modes by which the Severn might be very materially improved. One is by letting the tide go up, and another is by not letting it go up. If we were to stop the tide altogether at Hock Crib, it might be made a better job for all the lands above and for all the lands below, and for all the navigation, probably, without doing anything to control the tide.

2602. (Mr. *Hume.*) What difficulties do you allude to in controlling with regard to the flood tide?—If we were to do the best we could to make a channel all the way up to Gloucester, the tide comes so strong from the trumpet mouth of the estuary of the Severn, that it carries a bore all the way to Gloucester, and that is productive of great evil both with regard to navigation, and with regard to the banks of the land; and it is a very difficult thing indeed to control; whereas we could bring a river with 10 or 20 feet of water all the way down to Hock Crib, if we stopped the tide at Hock Crib, and pass all the land water by a weir, and never have the river silt up at all.

2603. Does not a tide so strong as that which comes up with the bore tend to keep and deepen the channel if kept within limits as to width?—It is difficult to keep it within limits. These things are all good or bad, according to their cost. If from Hock Crib we could be sure of 15 or 20 feet of water at all times to Gloucester, and all was quiet, it would be a fine thing, much better than having a roaring furious bore all the way.

2604. You think that benefit might arise from having, as it were, an inland navigation from Hock Crib, by keeping the tide beyond it?—I could take the whole of the land flood-water off over the weir not more than two or three inches thick during the heaviest floods that ever came down that part of the river into that navigation, and by steaming, or sailing, or tracking, there would be a perfect navigation for 60 or 70 miles up to Stourport.

2605. You have mentioned Rye Harbour; will you state on what principles the navigation of the harbour of Rye could be improved?—The only way to improve the navigation of the harbour of Rye is, in the first place, to get a good channel out from Rye to the low-water channel of the sea, which is about a mile and a-half from the present pier through sand. They are now acting gradually upon a recommendation of mine, in carrying out a breakwater straight across those sands, which, as far as it has gone, acts admirably well.

2606. Is it your object in erecting that pier to prevent the ebb tide from spreading over the sands on both sides?—It is to keep it to one place.

2607. Have you attended to the flow of the river above Rye?—A great deal.

2608. Have you visited Scot's Float Sluice?—Yes, many times. That has been lately rebuilt under my particular notice.

2609. What would be the effect of removing that sluice so as to allow a flow of tide upwards?—I must revert to what it was formerly, and how it came to be as it is now built. Many years ago the River Rother went up beyond Rye, up to the channel of the valley of Rother, a considerable distance, 15 miles at least. It was a very flat, sluggish, sort of river. It began to silt up a good deal, and the water came sluggishly to it, until at last a portion of the river was what was, at that day, termed inned out, they made a bank across the valley, and at the end they stopped the tide, and the lower land that began to be dry they reclaimed and stopped it, and that left those lands in *statu quo;* they did not rise any more after that. Subsequently the land outside the bank began to rise, as it always will where the tide is stopped, until other land in the valley became lifted higher than the first land, and they were inned out, and, I think, a third set were inned out until at last they came to Scot's Float Sluice, and there they made banks and carried the water off through the sluice as it now goes; and the effect is that the lands which were last drained and inned out are several feet higher than the land which was first inned out, and when they began those lands were many feet lower. Wherever we embank against the sea, in almost every case outside next the sea, the embankment of land rises very fast, but it never rises any more inside. If we take the case of the Nene at Sutton Bridge, that was effected at great cost, and they saved several thousand acres of land. Since that was done the land has risen six feet, and they are now taking 2000 acres more in from the open sea. Before taking down Scot's Float Sluice the banks of the river must be raised and strengthened to a great degree.

2610. (*Capt. Washington.*) To what degree, three feet?—More than that. As I have stated, the ground they last reclaimed is many feet higher than that which was first reclaimed.

2611. (Mr. *Hume.*) Then the volume of water that would flow up is so great that they would have to bank up?—It is, because what they first took in was so much and so high up the country.

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You would have to embank those lands out not only to high-water mark, but to meet floods on the high water again.

2612. You have attended to the progress of that?—Yes. If you embank out and take down the sluice then an effect will come of this kind—that the sea will then in that narrow and confined channel deposit the silt so fast that it would choke itself up in a few years. At Tillingham Channel, a little while ago, to my knowledge, the gates were damaged, and it was left open to the tide, and became silted up, as this would be in the course of three or four years, and they could do nothing with it; and that would be the case up the Rother now by taking down the sluice and contracting the channel.

2613. Would not a larger quantity of water flow up, and would not the scour by the ebb tend to keep it clean?—No, because there is not enough; you have no volume, no surface, no carriage of back-water behind; it is a little stream.

2614. Are you aware of what took place in 1812, when the sluice was broken down?—Yes, I am generally aware that there was a question raised that if they left it down it would be a good thing; because, for a short time, great effects ensued in the locality of the sluice in scouring away a great quantity of mud, but that very soon ceased, and the thing would have been as it is at Tillingham Channel.

2615. Are you aware what alterations took place in the depth of the water opposite Rye, and at the place where you have lately erected the pier?—I do not think the bar was lower than it is now.

2616. We have evidence stating it was 3 feet deeper than it was before?—I doubt it.

2617. The harbour-master, who measured it, states that that was the fact; and that vessels drawing a certain depth of water came up then which could not come up now, and did not come up before; therefore, how can that be reconciled with what you have now stated?—Those things must be taken with a great deal of reservation, I think. There never was, within the memory of man, a greater depth of water up to Rye from the ocean than there is now, I think.

2618. (*Capt. Washington.*) If you were to dredge the river Rother up two or three miles, would not that make sufficient channel for the flood-water to pour off?—The flood-water gets off now, and you would not have more flood-water than you have now. The tide-water would run in and out; but there is not channel enough in the whole to hold sufficient tide-water to do any good compared with the expense of obtaining it.

2619. Can you point out any mode, by making a reservoir or any other means, of improving Rye Harbour?—If they pursue the advice I have given they would have a much better and a very good harbour at Rye; there is a scour from above. Nature has already filled up the whole valley, not only to neap-tide mark but above it.

2620. (Mr. *Hume.*) Are you aware that, in 1812, when the sluice was broken down, that the water flowed up 15 miles?—Yes; so it would to-morrow.

2621. Would not the scour of that have an effect tending to keep the channel opposite Rye clear?—Very little indeed, and that for a very short time; there is hardly anything of it.

2622. Are you not aware that, by the proceedings in the Clyde, to which you have alluded, great benefit has arisen from dredging, removing from the bottom, and straightening the channel?—Yes, to some extent; and if you were to pursue the same thing at Rye which I have recommended, the same effects would, in a great measure, be obtained; but they have got no more back-water, and have no reservoirs for the tide.

2623. And yet, by dredging, widening, and narrowing, so as to make a uniform flow to increase the current, the channel has been deepened?—Yes; they have not increased the current much. I dare say the current was greater formerly than it is now, but they have deepened the channel.

2624. (*Capt. Washington.*) And thereby made a reservoir?—It is quite a different case. Comparing one thing with another, the channel at Glasgow is made between the low-water mark and high-water mark; that is, between Greenock and Glasgow.

2625. (Mr. *Hume.*) Do you mean to say, as your deliberate opinion, that the more you open the river Rother to the flow of the tide the more the harbour will silt up?—No; I mean to say that if you could make the whole valley into a large reservoir, and remove some 15 or 20 feet of silt for perhaps half a mile wide and 15 miles long, nearly as it is said to have been in days of yore, then Rye Harbour will be scoured out in grand style. If things were so at this moment, or approximating to it at all, that would in time fill up with mud again, and it would cost more to keep it out than keeping it out would be worth.

2626. Do you mean to say that, by the great quantity of flood-tide over the lands, which you say have been dammed out above, while that existed the harbour of Rye was deep in consequence of the scour from such a quantity of water?—I have no doubt that it was deeper than it is now.

2627. If the same principle is applied now would you not deepen the harbour by increasing the flow, and, consequently, increasing the scour?—Yes; but I cannot make this Board understand the exact difference between great things and little in that respect; for what you think would be a great thing in doing is that which I think would be a very little one.

2628. Is there not a principle upon which you propose to act, and is not that principle to remove, as far as possible, impediments to the flow of the tide, with a view of obtaining the largest quantity of scour out on the ebb as formerly existed?—Yes, that is true in the abstract. I state if you could do that, that it would do well for a considerable time. All you can do would cost a great deal of money, and have very little effect. My thoughts about these things are not only upon whether they can be done but whether they are worth doing.

2629. Then are the Commission to understand you to say that you do not disagree in the principle, but you think the expense of keeping up on a small river the agency of a large

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scour would be more expensive than it would be useful?—Yes; and I mean to subscribe to the principle which you mentioned to this extent, that I seldom recommend internal waters to be embanked that are covered by a neap tide.

2630. That is to say you would allow the full flow of the flood to give the benefit of the ebb scour in every case?—Yes; and I mean to go on to say that above Scot's Float Sluice you will find some quantity of land that would not be covered by a neap tide, but which was formerly covered by every tide.

2631. In consequence of its being dammed out?—In consequence of its being raised by nature to a higher level than neap tide.

2632. If it was covered with water?—Yes.

2633. With tide water?—Yes.

2634. Do you consider that the level now is higher than it was before?—Not higher than it was when embanking, but higher than neap tide constantly when it was embanking. The last lands embanked continued to deposit itself, and they were nearly as high as spring tide. It is astonishing how fast land, when it gets above neap tide height, will rise on every tide until it will get to nearly spring tide height. There is nothing we can do artificially which is worth doing for a deep back-water channel. I have spent many thousand pounds in trying to do that which you are now recommending—back-water or reservoirs to secure harbours. All reservoirs to fill by the tide are of the same principle, that the river would be above Scot's Float Sluice. I can revert to other reservoirs which are higher than the highest water. The channel to the Bute docks is kept open by scouring, and scouring by the reservoir higher than the highest tide; but I fill that reservoir, not from the sea, but with clear water from the River Taff, brought some miles above on a level; but there are many modes of working the thing.

2635. Is it your deliberate opinion that opening up back-water to allow the tide to spread over any land is no advantage to the scour?—I must answer that question with a qualification. I say the principle of back-water is excellent if it can be maintained, and can be made worth its cost. My deliberate opinion is, and my advice always has been, that it is improper to embank any land which is covered by neap tide, which water is necessary to keep open a harbour. Times will arise when the land gets higher than the neap tide. I mean to say it is not worth while to dig out reservoirs for the sea to run into to make scour water, if that water has a tendency to fill them up again, as it has up the Rother; and if you were now to throw down Scot's Float Sluice, and make the banks higher along the River Rother up to Robert's Bridge, it would begin to lay a shelf of mud on the two sides until there would be scarcely rivulet enough to bring down the land water; and the effect would be that the land flood coming suddenly down the channel would be obstructed so much by the deposit that the flood water could not get down, but run over the banks.

2636. Do you consider there is any peculiarity in the River Rother silting up by the flood tide more than on any other river?—No; it is so on all heavily charged rivers, and where the shores on the river are flat.

2637. Then in that case it should be the study to keep out the tide?—In all cases where it is proper so to do; where all the circumstances combine to make that necessary. No one rule or principle can be found to fit all cases. There is no engineering so difficult as harbour engineering, about which every one thinks he knows something, and the moment he begins to apply one particular principle to all general cases, it fails in 99 cases out of 100.

2638. You mean to say that each harbour, from its formation and locality, have peculiarities that require to be studied before you can act upon any general principle?—Yes.

2639. Are the Commission to understand you to say, as a general principle, that it is desirable not to exclude the tide water which has flown and covered land by the neap tide as you say?—As a general principle, where you want a scouring power, or a tide to do good, and a harbour through which water passes in the flood, you should never embank any lands above that harbour which are covered by neap tide, because every cubic yard of water which goes in, goes back again, and helps to keep the channel open.

2640. Are the Commission to understand that inclosures in the land stopping the flow of tidal water, must gradually injure the bar of the harbour to which that formerly served as a scour?—Yes, it will do so; and moreover, if it is not done by art, it will soon be done by nature.

2641. In what way can art in these cases assist nature best?—Art can assist nature best if the channel gets crooked by endeavouring to keep it straight. If it gets uneven in its depth, art can assist nature by endeavouring to keep the bottom even.

2642. You mean where eddies may have formed?—Yes. If the Rye Harbour people had had money enough, they would have had a better harbour by this time. They have got engineers among themselves, and what one man proposed, another man opposed, and so they have gone on to the present day.

2643. Then you consider the harbour has suffered by not having one continuous authority to direct their proceedings?—I think so.

2644. What is your opinion generally on the harbours you have visited with regard to the improvements that have been made; do you consider, that generally speaking, harbours have suffered as much by neglect as by attempted improvements?—They have both had their share in making harbours bad, but still many harbours in this kingdom are much improved from what they formerly were by engineering.

2645. Considering harbours to be works for national purposes, would it be proper in your opinion that the Government should have control or superintendence over all attempts to improve or interfere with the harbour?—They have a good deal of control as it is, and very little power of doing good. They have power to do evil more than to do good, I think, at present.

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2646. What powers do you allude to that are wanting to enable them to do good?—To enable good to be done if we take all the harbours in the kingdom, and apply them to national purposes, or otherwise, there should be one head or one Board as a branch of the Administration, and that of the highest possible character, and with sufficient funds at its disposal.

2647. You mean that a central Government Board acting with adequate authority should have a general superintendence of the harbours of the country?—I think that would be exceedingly good and very useful if properly administered, provided it was not made a jobbing Board.

2648. You consider that the Superintendent of such a Board ought to have the power to command the highest talent in the country?—Yes.

2649. What are the particular powers now that would enable a Board so formed honestly to carry out that which would be best for the interest of the navigation?—It is a very difficult question to answer. I sometimes see good done by those powers of the Admiralty, and I sometimes see evil done; it is a sort of power with which they may do mischief, but cannot do good; they have not much capital at their command to do good with.

2650. You mean to say that a Board so formed ought to have at their disposal means of assisting a local fund, or perhaps even without that assistance carrying out such measures as might be pointed out by science to improve the navigation?—I think they should have means of assistance. There are means of assistance now possessed by a Government Board, but in such a questionable form, that although I have known it do good, yet I have known some evils arise—I mean the Exchequer Loan Board; there are means of getting money to do certain works for improving the harbours and roads, or anything else. It should be a Board that did not change with politics.

2651. A permanent Board?—A permanent Board of the highest standing.

2652. From your observation in the different places where you have been, have you seen any disposition in a local Board to study more the immediate advantage at the place or of the time than the general interests of the port as a place for navigation?—The means of the local Board are always limited; they have no power to do anything except taxing commerce, and then there always comes a battle about that, with the different interests; and then if they apply to Government, the Government have no means, except by granting an Act of Parliament, to levy tolls and dues and so on.

2653. Do you consider that it would be an advantage that the Admiralty or a Superintending Board should have the power of naming a certain proportion of the acting Commissioners on the spot to prevent selfish local interests from interfering with national objects?—That is done now; I have to do with a harbour occasionally where that is carried out, that is, at Edinburgh and Leith; there are Government Commissioners there put in and at some other places.

2654. What is the inconvenience you observe; is it from a divided authority?—It makes a divided Board of it, generally speaking.

2655. Have you not seen, on the other hand, great evil arising from the local Commissioners allowing land to be inclosed, and jetties and obstructions to be raised which it was their duty to have prevented?—I cannot call to mind any particular cases; I have seen cases where things have been refused which could have done no harm, and others granted which would do a great deal.

2656. By the local authorities?—Yes.

2657. Then in what way could you suggest any better means by which these Boards would be obliged to attend to the national objects which harbours ought to be?—It always comes to this, what can we get by doing such and such a thing? That is the question. If a port wants improvement, those whose interests it lay in having it improved, will associate together and talk the matter over, and they say, if such and such a thing is done, this would be made a good port. They call in the engineer to state what it would cost; he will tell them to the best of his ability, something or other which may be very short of the amount. They go to Parliament to get power to make improvements and levy dues, and so on, in order to raise a capital for executing the works. It frequently happens that when they have got their powers and money, and expended what they have got, that they generally come short, and there they stop; there is not sufficient trade to pay the cost, and if there is not trade enough to pay the cost, who has any interest in going on with further expenditure? therefore the improvement necessarily stops, and Government, unless it is for express Government purposes, for national improvement or defence, or something of that sort, Government has no interests in private harbours, which may be merely to bring a few coals, or carry produce out; they have no interest in that directly.

2658. Is it not a question of great importance to any Government, looking to the coast of this country, surrounded by so many ships, to have places of refuge in the event of war, or bad weather. Is it not on that account a national object of great importance, to make every harbour as good as they can?—I think it is, but those things are only in degrees as harbours of refuge; there are few places where harbours of refuge could be made, and where they are made they cost a great deal of money.

2659. (*Capt. Washington.*) With reference to Rye Harbour, would you not, seeing there is a difference of 11 feet in the rise of the tide between the town and low-water edge in the bay, would you not recommend dredging the harbour, and up to Scot's Float Sluice?—Yes.

2660. Thereby would you not gain that great reservoir of scouring water in the channel of the river itself?—Yes.

2661. Would not that be of use in keeping away any tendency to form a bar at low-water mark, which there now is?—It would.

2662. If we dredge two miles in the bed of the river, above Scot's Float Sluice, should we not get great additional scouring power?—No, very little; you would obtain much more effec by regulating the channel from Scot's Float Sluice, down to the harbour mouth, and straightening that, and carrying out the eastern work down to the low-water mark; all that could be done for comparatively little money, and you would have a continually increasing good harbour.

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2663. Do you not think that the pier should be slightly curved in going out to low-water mark, or would it be better straight?—It depends on circumstances, as to the state of the tide at the place. In that place I think a straight one is best, or it might be convex instead of concave.

2664. Convex to the westward?—Yes; whereas in some other cases it is necessary to make them curve towards the centre; local circumstances there come into play again. In that case I think the straight one would be the best.

2665. Are you not of opinion that a depth of 20 feet at high water springs may be obtained in Rye Harbour and maintained?—I think 18 feet may be maintained at Rye at high water springs.

2666. (*Chairman.*) Is there any difficulty in the proposed railway crossing the River Rother above Scot's Float Sluice?—I cannot explain all the difficulties now, but going from the present line would be attended with greater difficulty than in going in the present line, because, if we were to cross above Scot's Float Sluice, we should have to tunnel considerably. All alongside the river is a steep cliff, and there is not room, if I recollect right, between that cliff and the river to carry the railway clear of building property. Keeping outside the river, it came nearly at right angles to the stream at both places, and there was no remonstrance against it at the time from the parties interested in it that I heard of.

2667. (Mr. *Hume.*) On public grounds?—As things now stand, I do not think on public grounds it makes sixpence difference.

2668. You do not think there is any chance of the harbour becoming, as it formerly was, capable of receiving a greater number of ship?—I am sure the parties, if they had the power to make the railway where it is laid down, would very readily bind themselves to alter it if such a state of things occurred.

2669. (*Capt. Washington.*) Are you aware that it is less than a quarter of a mile from the harbour where all the ships lay, and not above a mile and a-half from the sea at high water, and exposed to the swell of a south-westerly gale?—Yes; and I am aware of many places where works are in the same position. London Bridge is not a quarter of a mile from where the ships lie.

2670. (*Chairman.*) The object of the Commission is to prevent the navigation from being impeded, and if this railway is allowed to cross so low down, it is obvious that all navigation would be entirely stopped—can you suggest any other way?—I can suggest another way by saying the railway might cross higher up, but it does not follow that the railway should be stopped. We have already in this country swing bridges in contemplation, and some executed, and in Holland there is little else for railways. They can take no line but the one proposed without stopping the thing altogether, I believe. That is the way the parties stand for this Session. I myself see no reason at present why all the navigation could not go on through an opening bridge that has gone on, and all that ever will go on.

[*The Witness withdrew.*]

Mr. *John Peter Fearon*, Solicitor to the Eastern Counties Railway,
Mr. *Peter William Barlow*, Engineer to the Ashford and Hastings (Branch) Railway,
sworn and examined.

Mr. *J. P. Fearon*
and
Mr. *P. W. Barlow.*

2672. (*Chairman.*) (To Mr. *Barlow.*) Will you point out on the map the course the intended line of railway was to take across the river as now proposed?—The line in black is the line now proposed by the Company.

2673. Are there two railways before the Committee which intend to cross about the same part of the river?—Yes.

2674. What are their names?—The South-Eastern line from Hastings to Ashford, and the Brighton Company's extension of their Lewes and Hastings line.

2675. For which do you appear?—I am the engineer for the South-Eastern line. In consequence of the order of the Admiralty, directing that no passage of that river should be allowed below Scot's Float Sluice, I come now to ascertain the nature of the objection, in order to see whether it can be remedied, and to explain the kind of bridge that is proposed, in the expectation that it will in a great measure remove the supposed difficulty. The description of bridge will be a swivel bridge, with 30 feet opening.

2676. Our object being to prevent any impediment to the navigation, and at the same time to offer no unnecessary impediment to the railway, will you explain to the Commission how you propose that the railway shall cross so close to Rye without impeding the navigation?—It is proposed to cross by a swivel bridge of 30 feet span, and as much opening as possible in the river, so that there would be no impediment offered to the flow of the water; and it is very rarely that ships require to go up there, and when they do, they pass through the swivel bridge.

2677. (Mr. *Hume.*) What is the width from bank to bank?—250 feet.

2678. Do you propose any part of that to be solid, or all upon piles?—It will be as much on piles as possible, consistent with the construction of a swivel bridge. From the circumstance of its being a swivel bridge, it requires that considerable abutments should be made for the foundations of the swivel bridge to work upon. You might make it in one span if it were

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not a swivel bridge; but if it is a swivel bridge, you must have the abutments for the swivel bridge to work upon.

2679. How much of the 250 feet of water way would you take up by the two abutments?—30 feet.

2680. (*Chairman.*) 15 feet on each side?—Yes; there would be two abutments which the swivel bridge would work upon, and one or two rows of piles besides to support the remaining part of the bridge. I reckon 30 feet would be sufficient to take out of the water way.

2681. (To Mr. *Fearon.*) Would you be prepared to consent to the insertion of a clause in the Bill binding the Company, in the event of any serious injury occurring to the navigation by this bridge, to turn the line so as to cross above the sluice. In the event of Rye Harbour being improved in such a manner to make it of more importance, would there be any objection on the part of the Company to consent to the insertion of such a clause as would bind them to cross the river higher above?—I should think not; but I should state the feeling of the South-Eastern Board is, supposing this line to be made, they would have the deepest possible interest in the well-being of the harbour of Rye. So far from allowing any impediment, they would very willingly assist in improving that harbour, which they have always thought capable of improvement.

2682. (Mr. *Hume.*) Supposing it should be afterwards found, by the increase of the shipping and any accident likely to happen, would you oblige yourselves at a future period to undertake to vary your line and take it on the other side?—(Mr. *Barlow.*) I am not aware of any objection to that.—(Mr. *Fearon.*) I have no hesitation in saying, on the part of the South-Eastern Company, they will accede at once to such a clause. I perceive that that must be a condition, and if they do not accept that clause, there is an end of the Bill; there will be an end of it unless we get your consent.

2683. (Mr. *Godson*) (To Mr. *Barlow.*) Is there room between the cliffs in the river for you to cross above the sluice, supposing you were ordered to do it at a future day?—I have looked to that point; it might require more cost.

2684. Would it require a tunnel?—No, I think not.

2685. (Mr. *Hume.*) Then we understand you to say a swing bridge is proposed of 30 feet width of water way, including the piles and abutments?—Yes.

2686. (To Mr. *Fearon.*) You are prepared to make some offer with respect to improving the harbour?—If this Commission can suggest any plan by which the harbour could be really and usefully and permanently improved, the South-Eastern Company will be very ready to contribute 10,000*l.* towards that object, supposing it proved to your satisfaction that it would really be doing the thing effectually; because what every one has felt in that quarter is, that vast sums of money have been spent to no purpose.

[*The Witness withdrew.*]

Adjourned.

Wednesday, 9*th July*, 1845.

Present :—

Capt. Sir GORDON BREMER, K.C.B., in the Chair.

Mr. Hume, M.P.
Mr. A. Chapman, M.P.
Capt. Beaufort, R.N.
Capt. Washington, R.N.

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John Scott Russell, Esq., F.R.S., examined.

2687. (*Chairman.*) Will you be so good as to state your profession and place of residence?—I am an engineer, and live in London.

2688. The Commissioners understand that you have devoted your attention to the construction and improvement of tidal harbours?—I have made a good many experiments upon the subject.

2689. Will you state what tidal harbours and rivers you have examined and reported upon?—The Dee, the Mersey, the Clyde, and the Tay, are the principal I have either examined or reported upon. I have examined recently several, of which the report is in progress, written, but not yet published.

2690. (Mr. *Hume.*) What are the chief obstructions to the tide which are found, and in what way do they operate?—That is probably the point into which I have gone most fully in these observations. They were made for the express purpose of determining what the causes of the retardation of the tide were. It appears that the retardation of the progress of the tidal wave in ascending the channel of a river is not dependent, as was supposed, upon the mere area of water way, as it has been called, but chiefly upon the element of the depth of that water way, so that I found where the water way of the channel was most capacious, the tide suffered most impediment, and that in other cases where the channel was very much smaller, the flow of the tide was much more accelerated; so that I believe the one important point which these observations have served to bring out is this, that where the mean depth of the channel is greatest, independent of the area, the progress of the tidal wave up the river will be the most accelerated. There were some very strong cases of that which I found in my observations upon the Clyde. Some portions of the channel were of considerable width, and others were considerably deeper, and the shores, instead of shelving with a greater slope, were comparatively perpendicular, and it was found that the velocity of the tidal wave was considerably greater

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where the channel was narrow and deep, and where the sides were nearly perpendicular; that that was the form which was most favourable for the progress of the tidal wave. In the other case the spreading shelving banks seemed to impede the progress of the wave, although they gave a much larger area of water. The experiments which I have made prove that the tidal wave is propagated according to the same law as the wave called a wave of the first order. Now I have found in the wave of the first order, and in all tidal waves that I have examined, the velocity of propagation of the tidal wave is proportioned to the square root of the depth, and it is because the tidal wave is a wave of this order, that its speed is proportioned to the square root of the depth; therefore that so far as a mere matter of generalized fact that the velocity of the tidal wave is proportioned to the square root of the depth; but I can give a few numbers here which will state exactly what the velocities observed of the tidal wave are in all depths of channel. My experiments upon tide and other waves have been of 10 years' standing in those rivers which I have already mentioned, and in artificial channels which I also constructed for the purpose of comparing with them. My first object was to make experiments on different channels, some of them artificial and some of them natural channels, in order to ascertain what law the propagation of the wave followed, and I found that I could, supposing the bottom level, determine with the greatest precision the velocity of the tidal wave when I knew the depth of the channel, and the following are the results:—In 10 feet depth of water I found the velocity of the tidal wave to be 12 miles an hour; 20 feet depth 16 miles an hour; 30 feet depth 20 miles an hour; 50 feet depth 26 miles an hour; 70 feet depth 32 miles an hour; 100 feet 34 miles an hour. I made the same experiments in a channel of the same depth, but shelving gradually to the bottom, and I found the effect of that contraction arising from the shelving sides which virtually diminish the mean depth, though they do not diminish the greatest depth, to be to reduce the velocity of the tidal wave to just one-half; and I found that that was not owing to the dimension, because if I made the channel twice as large by widening it, still if it sloped uniformly, however wide I made it, I never increased the velocity of the tidal wave so long as the greatest depth remained unchanged.

2691. Can you explain how that is?—The principle of this is fully explained in the report on waves made to the British Association for the Advancement of Science in 1844.

2692. Will you explain in what way the tidal wave is retarded by shallows in the bed of the river?—I find that in the deep part of the river the velocity of the tidal wave is that which is due to the depth, as given in the above table, but that the moment it comes to the shallow part it moves only with the same velocity through that shallow part as if the whole length of the channel were only of the shallow depth. It retains none of the acceleration in that shallow part which it had acquired in going through the deep part of the channel; it instantly accelerates its velocity by precisely the velocity due to that depth, however great it may be; so from shallow to shallow, every shallow that it crosses, it may be considered for the time being as a shallow river of that depth.

2693. (*Capt. Washington.*) By means of the table you have referred to, could you, by knowing the velocity of the tidal wave, predict approximatively the depth of water in the channel of a river?—Yes.

2694. (Mr. *Hume.*) If that is a principle which you have established, does it not follow that the best means you have of improving the navigation is to remove every such shallow, however small it may be, and render the volume of water as nearly rectangular as possible?—That follows necessarily.

2695. From the observations which you have made in the different rivers you have named, have you had an opportunity of proving the correctness of this principle?—I have had tidal observations accurately made before and after the date of such alterations, and in every case the acceleration of the tidal wave has corresponded very directly with the increased depth of the channel.

2696. What effects are produced on the flow of the water at these places where shallows are produced, or where shallows are removed?—The first effect of a shallow part in a channel is to keep back the time of the commencement of the flood much more than it keeps back the time of high water; the consequence of which is, that it diminishes very much the total time of flow up the river, the whole period of flood is very much shorter, and in consequence of this effect on the length of time of the flow, the total quantity of water carried up the river is very much diminished; not only is it very much diminished, but the rapidity of the flood current is very much increased while it lasts, and the duration of the ebb is very much lengthened; the consequence of that is, that there is a much greater tendency to carry up obstructions, and fill the river by the flood, than there is to clean it by the ebb.

2697. Are there not retardations by projections on the sides of the river?—There are. I find that the chief effect of lateral projections or inequalities on the banks is simply to retard and to break up the flow of the tidal wave, so as to diminish very much the quantity of wave which enters a river, but without affecting materially the time of the progress of the wave.

2698. Do you mean that it prevents that quantity of water from flowing up that would flow if the banks were smooth and continuous?—It does.

2699. In what way have you seen these principles exemplified in the case of any of the rivers that you have visited?—The first case in which I have seen the results of those observations verified is the case of the River Dee; that, I think, is the most notorious case with which I am acquainted. I have some very old plans of the River Dee in the middle of the last century, in which I find the progress of the tidal wave through the deep channel direct to Chester to be very rapid, and the flow of the water up the river very great, but some time ago the River Dee Company diverted that river from its former course, and turned it into an extremely narrow channel, a kind of canal; in that canal I made observations which showed that the

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velocity of the tidal wave in this part of the channel so turned into a canal was in exact conformity with the table which I have just given in; but immediately below that the channel spreads out into a wide and shallow and crooked course; and there I found the velocity of the tidal wave, although in a much wider channel, very much retarded by the shallowness of the Dee. I consider that also to be a case in which the immediate interference of some power or other is necessary to prevent the entire destruction of the channel; for in 1836, I had an opportunity of observing how injurious a very small obstruction might be in totally changing the channel of the river. I found the river issuing from this canal, and going straight down out of this channel to a place called Flint; and I found that the course of the deep part of the river had for a long time kept straight along the coast until some proprietor chose to reclaim a piece of land in the immediate vicinity of Flint, and extended his enclosure into the water-way; I was able to trace then most clearly the former path of the river previously to this projection, although it has since been entirely obliterated.

2700. In what year was that?—It was in 1834 or 1836. This projection was extremely small, but a strong one, and such has been the effect of that projection as to divert the course of the river through a space something like a mile and a half, diverting it nearly at right angles across the estuary out of its former path, so as to ruin altogether the harbours which were originally established upon the south side of the coast without giving the opposite coast any benefit, for it did not turn it to the opposite coast, it merely turned it through the extensive sands of the estuary, and above that point it had an equally injurious effect for 3 or miles up; for instead of one channel on the south side, as formerly, it branched off in various directions.

2701. (*Capt. Washington.*) Has the obstruction been removed?—No, it has not.

2702. (Mr. *Hume.*) What effect has that had on the navigation?—The effect is such that there is now no defined channel whatever above Flint between the mouth of the canal, which the Commissioners made, and Flint Castle.

2703. What is the distance?—About 5 miles.

2704. You consider that to have been produced entirely by the small enclosure projecting into the river on the south side?—I do.

2705. Do you consider, upon the principle upon which the stream has been turned, the removal of that encroachment might bring the current back to its old course?—With some additional works I have little doubt it would. I have little doubt that the Dee might be restored to a tolerably straight and good navigable channel, and that it might be made a good tidal river.

2706. Have you examined the distance from Chester to the sea, and are there any other impediments exemplifying the principles which you have now laid down?—I am not aware of any other considerable impediment except a rock which is at some distance above Flint, which also interferes with the flow of the channel.

2707. Have you made any report on that river?—Yes; I made a report to the Improvement Commissioners of the river Dee.

2708. Have they acted upon it?—They endeavoured to obtain an Act of Parliament, but they found the proprietors of land in the vicinity opposed to the improvement of the river.

2709. Do you consider that if the whole of that navigation was cleared in the way you could point out, the river could be made navigable for vessels with ease up to Chester?—I have not the least doubt that Chester might be restored to its eminence as a port.

2710. Was it ever of great eminence as a port?—It was of such eminence as a port that large vessels could come up and ride under the walls of the fort.

2711. At what period was that?—During the early part of the last century.

1712. What sized vessels can go up to Chester?—The largest sized vessel that finds its way to Chester is in extremely high spring tides, and then only draws from 7 to 9 feet of water.

1713. Have you made any estimate of what the expense would be if power were given by Parliament to make Chester the harbour you point out?—An estimate was made at the time of the expense only of such partial improvements as the Commissioners would be able readily to accomplish, but we found a material improvement could be made for an outlay of 50,000*l.*

2714. Who are the Commissioners?—The Commissioners are inhabitants appointed as Commissioners for the improvement of the river Dee.

2715. You have stated that the Chester navigation at one time admitted vessels of considerable size up to the city: can you state from your observations of the river what are the causes of the injury that has taken place?—Besides the cause I have already mentioned, there can be no doubt that the entire ruin of that estuary has been owing to the injudicious reclaiming of land to an enormous extent by a large Company formed under an Act of Parliament for that purpose

2716. In what year?—I think about 1750.

2717. Was that Company promoted by the inhabitants of Chester?—No; it was a private Company of totally different individuals, and under the Act of Parliament certain powers were conferred upon the said Commissioners of the City of Chester, of whom I have already spoken, with the intention of enabling them to provide for the navigation and keep it open; but their powers are totally ineffectual, the provisions are not adequate for the purpose.

2718. Do you know whether any reference was made to the Admiralty, whose duty it was to protect that as a tidal harbour?—I have not heard of any such reference.

2719. Can you state how high the tide rises at Chester?—The tide, at spring-tides, does not give more water up to Chester than than 9 feet 6 inches.

2720. What is the depth of water at the mouth?—The depth of water in the lower part of the river is capable of taking up the largest ships of any class that you would wish to take up.

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2721. Can you state how high the tide rises at the bar, and how high at Chester at ordinary spring-tides?—The tide rises at the bar 33 feet, and at Chester it is what I have already stated, for it is all but dry at low water.

2722. Do you know what the difference of rise in the bed of the river at Chester is as compared with the rise at the mouth?—At Flint the tide rises fully as much as it does at the mouth.

2723. Then if proper engineering works were applied between Flint and Chester, to what extent could the navigation be deepened up to Chester?—I have no doubt that by works of even moderate extent, 22 feet of water could be secured to the town of Chester.

2724. Would you in that case apply the principle of deepening the channel so as to give the greatest cube, on the principle you have already laid down?—Precisely so; I should endeavour to obtain the greatest mean depth throughout.

2725. Would you also, as regards the banks of the channel, endeavour to narrow them to resemble as much as possible a canal?—I would do so, with proper provision, however, for maintaining as large a quantity of flood surface as possible, on account of the bar.

2726. How far is the bar of which you have now spoken from the Point of Ayr?—Five miles, and that bar lies north-west from Ayr Point Lighthouse.

2727. What is the depth at low water in spring-tides on that bar?—12 feet.

2728. How high does the tide rise on the bar?—33 feet in spring-tides.

2729. Consequently there would be upwards of 40 feet on the bar at spring-tides?—Yes.

2730. You have stated that large quantities of tidal lands have been reclaimed since the middle of the last century; are you able to state what the depth of water at the bar was before that took place?—I am not prepared to say how much deeper it was upon the present bar, but from Ayr Point upwards, where it is now nearly dry, it was of such a depth that the largest ships could ride in it at all states of the tide.

2731. Do you consider that that change has been produced by the injudicious enclosing of tidal lands under the sanction of Parliament, to which you have alluded?—There can be no doubt of it.

2732. Is it your opinion that no permission, under any circumstances, ought to be given to diminish the volume of water entering any of our tidal harbours?—I think that should be most scrupulously maintained with a view of scouring the channel with as large a body of water as possible, and where channels are narrowed it should be done also in conformity with this principle. I think it quite possible to obtain a good deep rectangular channel for the progress of the tidal water-way, and at the same time to keep unimpaired the whole lateral area for the reception of the tidal water to produce the scour; this could have been perfectly provided for in the case of the river Dee, along with the narrowing of the channel.

2733. Do you mean to say that a considerable portion of land might have been enclosed, provided compensation had been made by an addition of water by deepening the channel?—Perfectly so.

2734. Is it owing to the want of that provision that the injury has been done to the harbour of Chester?—Solely to that.

[*The Witness withdrew.*]

Adjourned.

Friday, 11*th July*, 1845.

Present:—

Mr. HUME, M.P., in the Chair.

Captain Beaufort, R.N. | Captain Washington, R.N.

Mr. *James Walker*, C.E., F.R.S., examined.

Mr. *James Walker*, C.E., F.R.S.

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2736. (*Chairman.*) Will you state to the Commission what tidal rivers and harbours you have examined and reported upon?—Yes; they are numerous:—

Aberdeen,
Ardrossan,
Arbroath,
Barrow,
Belfast,
Bridlington,
Bude,
Burntisland,
Caledonian Canal, entrances,
Carnarvon,
Castletown,
The Clyde,
Cuxhaven,
Douglas,
Dover,
Dudden,
Dunbar,
Dundee Harbour,
Fraserburgh,
Fleetwood,
Granton,
Greenock,
Hamburgh,
Harwich,
Holyhead,
Hull,
Kingstown,
Leith,
Lowestoft,
Lough Swilly,
Lough Foyle,
The Mersey,
Montrose,
Newcastle,
Newhaven,
Newport,
Piel Harbour, in Lancashire,
Portsmouth,
Plymouth,
Port Glasgow,
Port Patrick,
Ramsey,
St. Katherine,
St. Sampson's and St. Peter's, Guernsey,
St. Helier's, St. Catherine, and other Harbours in Jersey,
The Severn,
Seaham,
Southwold,
Sunderland,
Thames,
Usk,
Wear (River),
The Welland,
Weymouth,
Whitby,
Whitehaven,
Whitstable,
Yarmouth,
The Yare.

Besides other rivers and docks.

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2737. In the course of your experience, have you been enabled to lay down any principle that is generally applicable to the improvement of tidal rivers?—No. I have found that each case must be treated upon its own merits. The object aimed at in rivers which depend upon the tide has always been to prevent as much as possible any diminution of the tidal water. Where the river depends on land floods, then the object has been not so much to trouble oneself with the tidal water, as to regulate the width of the river, so as to give uniform depth by creating an increased uniform velocity. The Clyde, which is particularly referred to, and upon which I have given evidence at great length before the House of Commons, and written various Reports, is as good an illustration of that case as any that could be given, because the upper part of the Clyde, I think, entirely due to the land floods, and the lower part, the estuary of the Clyde, entirely to the tidal water.

2738. In the first place, do you allude to those where bars are formed, for which you wish to reserve the greatest quantity of tidal water as an out-scour?—Yes; the object is the greatest quantity of water, where the bar is to be removed by the effect of tidal water.

2739. Are the Commission to understand that in every tidal harbour where a bar is an impediment to its navigation, your principle has been to obtain as great a quantity of flood as possible, with a view of increasing the scour of the ebb?—Yes, as a general principle; but there are tidal harbours in this country which do not depend much on the tide, even for the removal of a bar, but depend almost entirely on the land floods. I have lately had a case before me, to which I have given a good deal of attention, that of Whitby: it depends almost entirely on the land floods, and very little indeed on the tidal water; at the same time I have recommended that no encroachments be made even on the tidal estuary without proper notice being given to the Commissioners, and the encroachment being approved by them.

2740. Where you recommend narrowing and straightening the channel of any river, do you take into account the necessity of giving compensation for the diminution of tidal space by deepening, or in what way do you compensate for the narrowing which reduces the quantity of water?—All I said with regard to narrowing, was applicable to cases where the river owes its capacity to the land freshes. I have already said, that in cases where I consider the river to be the effect of the tide, my object as much as possible has been to prevent any diminution of the tidal water between high and low water. I need not say that any deepening below low water has very little effect in increasing the quantity of tidal water.

2741. Unless that depth can be made throughout so as to admit the flow of water from the lowest part?—If you make it deep, and that depth is below low water, the space below low water and the channel of the river is always filled with water, and that does not go out or in. Take the case of the river Thames. The removal of all the shoals which I have so strongly recommended in my Report of 1843, would have but little effect in increasing the quantity of tidal water that enters the river Thames.

2742. What are the chief obstructions then to the propagation of the tide which you generally find to exist?—Irregularities in the width, and a contracted channel.

2743. Not shoals?—Shoals also; but if they are under low-water not by an means to the same extent.

2744. After the water arrives to the same level at the head of the river as it does at the entrance of the river, then no removal of shoals would be an improvement?—Yes; the removal of shoals may still do good—the water at the head of the river may rise higher than at the entrance.

2745. Will you explain in what way these obstructions operate?—They operate the same as an obstruction in a pipe would prevent the liquid passing freely through it.

2746. Narrowing the capacity?—Yes; and in that way diminishing not only the volume, but the momentum.

2747. In what way would you increase the momentum?—By straightening the banks, removing the shoals, and giving a uniform width.

2748. Then your wish is on all occasions to keep the banks as wide as possible where the tide flows, but to have them uniform, if possible, which increases the momentum?—Yes, and to have uniformity, particularly where the river depends on the land floods.

2749. Then in what way do you best remove those obstructions?—If they are to be removed by art, the best way that I know of is by dredging, but more good probably has been done by the narrowing and regulating, and acting by an impulse on the channel, and when the worst part is taken away the velocity often does a great deal towards it without dredging.

2750. So that by a judicious application of those principles nature herself may remove a large portion of the obstruction which otherwise would continue?—Yes.

2751. Are you of opinion that depths in rivers, and their powers of scouring, are chiefly due to the volume of water brought down in freshes or the tidal water?—To both, as the case may be.

2752. Is there more fear for our rivers by the rubbish brought down by the stream, or to sand and silt brought in by the flood tide?—That is one of the general questions which depend on the particular case. I know rivers where the obstruction is very much caused by the breaking down of the banks and the debris being carried into the stream, and others where it arises from the sand carried in from the sea. I think the Thames is a case where the deposit is brought from the upper part of the Thames, the city, and elsewhere. Whitby is a case where the obstruction is entirely caused by the sand which is washed in from the sea.

2753. Can you state any particular instance where the application of those principles has been attended with success?—I think in every river I have mentioned, where I have been consulted, the same principles have, according to different modifications, been attended with success. The laws of nature are uniform, and what operates in one river would, under similar circumstances, operate in another. It is very fortunate for engineers that the application of those principles, like the application of other cures, requires the advice of the practitioner.

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2754. Generally speaking, whatever interrupts the flow of water up or down is injurious to the channel?—I think not. Whatever interrupts the tidal water is injurious to the channel that is dependent on the tide, but the very cause that I have explained as the best way of improving rivers, which is by judiciously narrowing them and improving their depth, produces its effect, by forming an obstruction to the passage of the water.

2755. These improvements are to assist the stream by making the sides and banks uniform?—Yes; and in many of our rivers, the first improvement, where the parties have not been enabled to make the continuous narrowing, has been the carrying out jetties opposite to the shoals, and increasing in that way the velocity of the stream on the shoals.

2756. With a view of carrying walls from the jetties up or down to regulate the stream?—Yes, afterwards, when they can afford it. The Clyde was done in the jetty way when they had not money to do more, and they are now going on connecting the ends of those jetties.

2757. (*Capt. Washington.*) Would not the jetties have been sufficient without the parallel banks?—No, they would by no means have answered so well.

2758. Was not the original intention of Goulburn that those should suffice?—I dare say if Goulburn had had the question put to him he would have said, when you can afford to connect them do so, because it is evident the jetty only operates by increasing the velocity where the jetty itself exists, and for a short distance lower down; that in the space between jetty A. and jetty B. (going down the stream) immediately after jetty A. is passed, the river tends to resume its velocity, as if neither jetty A. nor jetty B. were there, or as if they were a great distance from each other. The best way, therefore, of getting an uniform velocity is to make a continuous line, or something that will have the same effect.

2759. Is there no rule you can lay down with respect to the place where jetties may be placed?—None that would be universally applicable. The plan lying before me is, I see, a plan of Barking Reach in the Thames. Suppose a jetty run out to the low water line from the south side from one point and another jetty at half a mile above it, the effect would be to increase the velocity opposite to each jetty, and therefore to remove the shoal which is marked on the plan before me as Barking Shoal, if it is a moveable material; but this mile between the jetties would scarcely be affected in point of velocity. I think it is quite impossible to lay down any general rule, the application of which would be so uniform as that an attempt to do so might not do more injury than good.

2760. Then each river and each locality requires to be attended to; but the principles which you have laid down should be always acted on?—Yes. Having had put before me this sheet of the River Thames, which has Barking Reach on it, as far as my recollection goes, Barking Shoal is peat on the surface, and therefore that is a case where dredging is wanted. That is one of the cases referred to in my Thames Report.

2761. Have you not, in your Report of 1842 to the Navigation Committee of the City of London, stated that Barking Shelf, commencing opposite the creek and continuing nearly half a mile down, and extending nearly two-thirds of the river, with water only from six to ten feet in the line of the navigation, that that you consider the worst shoal in the river, and yet it might be removed if proper means were employed?—I have.

2762. What are the means you would employ?—Dredging the peat or rock away, and then either the Trinity House or the individuals who are desirous of having the gravel would take the remainder away.

2763. (*Capt. Beaufort.*) Taking for granted that gravel is under the peat?—Yes, which I believe it to be; I think you will find it generally so in the Thames.

2764. (*Chairman.*) Are you aware of any reason why that which is so important to the navigation of the Thames has not been removed as recommended?—The want of a party of some denomination or other with funds to do it; and I think it is much to be deplored that so very important a measure as the removal of those shoals, which are so injurious to the River Thames at present, should, for the want of 60,000*l.*, be left so long as they have been.

2765. In that Report it is stated that there are no less than 14 shallows or shoals from London Bridge downwards in the river, and that all of them might be removed without any difficulty if an expense of 60,000*l.* was incurred?—Yes.

2766. Have you any reason to alter the opinion you gave upon that occasion?—I have not. I have not entered into that computation since; but that was intended to be a fair estimate at the time.

2767. Could you furnish the Committee with any data as to the cost of dredging?—Yes; but in the next room you have an individual (Mr. English) who is better authority for that than I am. I speak from recollection, but I think it is probable that I took the dredging of the peat, the useless stuff, at something like 9*d.* to 1*s.* a cubic yard.

2768. In this Report did you contemplate making the depth of water in the River Thames 12 feet in all places, from London Bridge down to below Barking Reach?—Down to Gravesend.

2769. That, in fact, if carried out, would be clearing the river of all those impediments that now interrupt it?—Yes, to the extent of 12 feet at low water up to London Bridge, and a width sufficient for navigation.

2770. Is it your opinion, from the experience you have had in the difficulties that have been met in carrying out improvements, that in every river there ought to be one superintending power to direct all its operations where the interest of navigation is affected?—Yes. Before leaving the subject of the estimate of the river, I should say that I supposed the material to be of ordinary quality. There is some material in the river, a shoal called Whiting Shoal, near Limehouse, which is now being removed by the Navigation Committee, and for which the cost must be 5*s.* per cubic yard, for it turns out to be a natural concrete. A liberal allowance ought to be made for contingencies.

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2771. In the various harbours you have visited have you found the navigation more injured by neglect than by erections within the tidal waters?—I am not prepared to answer that question without looking into every particular case. I have no doubt that a great deal more good might be done to rivers than all the evils that have been done to them by encroachments.

2772. Take the case of Southwold Harbour?—Southwold Harbour has, no doubt, been injured by the neglect of the Commissioners, if the Commissioners existed at the time when the embankments were made, and on the other side by the activity of the parties who have enclosed the marshes. I have reported upon that river at great length. I think there have been no inclosures for nearly half a century.

2773. You have stated that there should be some general superintending power to manage the River Thames?—There is a superintending power to manage the River Thames; the Lord Mayor has the power, as conservator.

2774. Has the Lord Mayor sufficient power to carry out the improvements which you have recommended?—I should think he has, if he has the means. He is now removing Whiting Shoal, and the removal of Blackwall Rock, opposite the Docks, was done some 30 years since. There is power enough to remove the shoals at present, if there are adequate funds applicable to the purpose, and a determination to do it.

2775. Do you think that in a great commercial country like this that the clearing and improving of the harbour should be left to the Mayor of any corporation; should it not be the duty of the Admiralty, or some Board connected with the Admiralty, to see that the rivers are kept in proper order, and where they are not sufficient, to improve them, if possible?—That is a very large question. But suppose the case of a Mayor, or of a local Commissioner, or a local Board, whose immediate interest is to take care of the river, such for instance as the River Mersey: I think that the merchants and shipowners of Liverpool, who are the Commissioners of the River Mersey, are, with a professional man who knows what he is about under them, the most likely class of persons to be vigilant conservators of the river. A general surveillance or Harbour Board of Reference would at the same time probably be unobjectionable on public grounds.

2776. Then how do you account, in the case of the Mersey, for having allowed for 50 years a deep channel to exist, Victoria Channel, without their availing themselves of it until the Admiralty Surveyor found it out?—I am not aware of any proof of its existence for 50 years. The sands there are shifting; but the very accurate and excellent surveys made by the Admiralty have no doubt discovered shoals and channels in rivers. These surveys have done great good wherever they have been made. The discovery of evils is one thing; remedying the evils when they are discovered, is another. In the case of the Mersey, after the discovery was made by the Admiralty Surveyor, the trustees of the river immediately set to and discharged their duty very diligently, and I believe sufficiently, in marking out the channel, and deepening it, employing the same officer, Captain Denham, as their permanent marine surveyor.

2777. On that rule, ought not one of the first steps of the Government to be to have every port and harbour properly surveyed?—I think so, and that is being done. I hope that nothing will interfere with that very efficient and regular system which is now being followed up by the hydrographer in giving such excellent charts of every river where the tide flows, as well as of the coast.

2778. As far as these surveys have yet been done, they have been highly beneficial, and on that account you are of opinion they ought to be as general and as soon as possible executed?—Certainly.

2779. From what you know as the system adopted by the hydrographer under the Admiralty in obtaining surveys of the harbours, is that the best plan that can be adopted?—I think so.

2780. (*Chairman.*) Having made accurate surveys of a harbour, what are the steps you would recommend to improve or preserve it?—To have an efficient conservancy over it.

2781. Should not that conservancy be, as it is one authority under the Crown, to prevent local or selfish interests from interfering with a general trust?—Local interests may interfere with the Trusts on the one hand, and I find that members of Parliament having private and local interests, interfere with the Government on the other.

2782. The question is directed to whether an officer acting under the Crown without local bias, or without Parliamentary interference, is not a proper authority for preserving the rivers and harbours of the country?—Certainly, a very excellent officer for preventing the evils of local influence which you have referred to; but I am not at present prepared to give an answer, saying that I think it would be desirable for the good of the country that all the harbours of the country should be solely under an officer appointed by the Government. I have not considered the subject.

2783. Take, for instance, Southwold Harbour. What is your opinion with respect to the Trustees of Southwold Harbour, who are entirely local, landed proprietors chiefly?—For the last 40 years, I think, there have been no encroachments on the Southwold Harbour. I am to suppose, therefore, that during those 40 years the Commissioners have interfered to prevent encroachments. If the local interests were superseded, the ultimate evil arising from distance and other causes might be still greater.

2784. (*Capt. Washington.*) If 1500 acres of marsh land, on the banks of the river Blyth, lying below the level of high-water spring tide have been embanked, could such an abuse possibly have occurred, had there been anything like a conservator or Government officer to look after our harbours?—I believe there always was an officer, the harbour-master. Upon the subject of this river I have given my opinion that the embanking of so much of the marshes from the harbour has been an evil, but it must not from that be supposed that in all cases, or even generally, the embanking of land that is below the level of high water is an evil. The river Thames, from London down to its mouth, was at one time six times the present width,

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and many thousand acres of land, which are eight feet below the level of high-water, have been taken from it; but the effect of that has, as regards the navigable part of the river Thames itself, been an improvement.

2785. (*Chairman.*) But in this case, the London river, an adequate breadth has been reserved for a channel?—Yes.

2786. But in Southwold that is not the case?—I do not think the evil in Southwold Harbour arises from the narrowing of the navigable channel. I do not remember having thought that it was too narrow, but it arises from the tidal estuary being diminished so as to diminish the back water that scours the harbour. Other professional men may differ from me; I have given that opinion very fully and very largely; my Southwold Report is printed; so that what I stated there deliberately is better than any evidence I can give at present, after a lapse of several years.

2787. On the principle you have stated respecting Southwold, has not the narrowing of the banks of the Thames, and diminishing the reservoirs for tidal water, had an injurious effect on the navigation of the Thames at its mouth?—It has had, in my opinion, the effect of increasing the shoals at its mouth; but the effect that it has had in improving the navigation of the river Thames itself upwards, is probably greater than the evil done by increasing the shoals, and that is just the case which shows the danger of laying down general principles, and acting upon them without knowing the particular case upon which you are advising, and taking the various interests into consideration.

2788. Upon that principle may not these shoals that have now increased below the Nore go on increasing until the navigation is interrupted?—No; I think unless you take some means to reduce very much indeed the tidal water of the river Thames the state of the shoals at the mouth of the river Thames have long since—centuries since—been in equilibrio with the disturbing cause. The surveys that have been made of the river from time to time show, I think I may say generally, that where there is an increase on one shoal there is a decrease on another.

2789. Then, in all the improvements you recommend for the Thames, you do not advise the decreasing of the volumes of water by the flood?—Not unless by the decreasing you can show you are going to do a greater good. Even in the Report for the Improvement of the Thames every embankment that narrows the Thames has the effect of in some degree of reducing the quantity of tidal water. Whilst I have recommended equalizing and narrowing in some places, I have also recommended deepening in others.

2790. (*Capt. Beaufort.*) Have you read Mr. Price's Report on Falmouth Harbour?—Yes.

2791. Have you had any evidence before you at any time about the nature of the bottom of the harbour?—Yes; but I forget what the nature of that evidence was.

2792. The question in Parliament at present is, as well as among people interested in harbours, on the propriety of allowing the dock to be erected. All are equally interested in getting Falmouth made into a good harbour, but the opposition people say, if they can scrape it out, there is no danger of its filling up again. Do you think there is any probability of that statement turning out to be well founded?—I do not think there is much danger. I do not think there is much sediment in Falmouth Harbour. I have reported my opinion to the Admiralty.

2793. What has produced those large banks that cover the whole of the inner harbour?—I cannot say, probably they always existed; there are natural irregularities below the surface of the water as there are above it.

2795. From anything you have seen since, have you any reason to alter the opinion stated in your Report on the subject?—No.

2796. (*Chairman.*) Have you been down to examine the spot?—No.

2797. (*Capt. Washington.*) Would it be safe to trust to a dredged channel keeping open?—It would. My advice to the Government about it would be to encourage it by all means, and let them do it. If considerable capital were expended in making docks, and they are obliged to dredge the way up to them, they will maintain the level, although at a future expense of dredging.

2800. Would you recommend that they should be called upon to give security for the completion of the works within a time to be fixed?—Yes, this might be, in cases, a prudent precaution.

2801. Will you state any time?—I should say seven years at least.

2802. What security should be taken, that if begun and not completed, they should be called on to remove the obstruction?—You must either take personal security, or as that which has been done in similar cases; for instance, in the case of building Vauxhall Bridge, a sum of 30,000*l.* was invested by the Company in the names of trustees, for the purpose of removing any obstruction in the river that should be made, and not to be surrendered to the Company until it would be sufficient to finish their bridge.

2803. After that was it given up?—Yes.

2804. If any portion of these dykes forming the docks are allowed to remain, supposing the works not to be carried out, would not that injure entirely the navigation up to Penryn?—If they formed an obstruction at all in the water-way they would. The velocity of the water is very small indeed.

2805. As the velocity of the water is not much, would there not be a greater tendency to silt and fill up from Penryn downwards?—The question is, whether that tendency would be increased by any encroachment on the stream.

2806. (*Chairman.*) Would not the tide from the dock upwards be entirely stopped?—Undoubtedly. The abstraction of the portion of the tidal water that will be taken off by the formation of the gates and locks for the purpose of making this part into a still or dock, is so far an evil. What I had to consider in giving that opinion to the Lords of the Admiralty was this, whether a greater good was not done to the commercial interest of the place by forming a

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large dock, than the evil done; and, in my opinion, the balance was decidedly in favour of the measure if completed.

2807. What sum of money do you think should be taken as security?—The projector's estimate being 230,000*l*., if from 15,000*l*. to 30,000*l*. were invested till they gave satisfaction to the trustees, I should think that would be ample for removing any obstruction.

2808. Is there anything in addition to what you have recommended in your Report of 1842, which you consider would be beneficial for the purpose of improving the navigation of the river Thames?—If the question refers to the parties who are to carry the recommendations into effect, I should say, that at present the improvement of the Thames seems to be a good deal hung up by a dispute between the Commissioners of Crown Lands and the City of London, in respect of the ownership of the soil of the river. While that dispute is going on, (and from all I can hear, it is likely to be a very tedious one,) the improvement of the river seems to be at a stand still; and the way in which it appears to me that it could be best carried on, would be by a Commission for the purpose of improving the river Thames, in which the different interests, the present conservators (the City of London), the Admiralty, the Crown Lands, the Corporation of the Trinity House, and the mercantile interest of London, would be fairly represented. I think if the Commission were of that character, formed by Act of Parliament (if an Act be necessary) that it would be extremely useful, and might go on with the improvements, while the two great bodies I have referred to are at law, with regard to the right of soil.

2809. Is it most desirable that that dispute, as to who is the conservator, should be settled as speedily as possible?—Yes; I believe there is no doubt of the Lord Mayor being conservator, but if a Commission, such as I have referred to, were formed, then the evil arising from the law-suit would not be felt. What I have now said has been a subject of conference at the Admiralty; I have also stated it to influential individuals of the city of London, and to the Commissioners of Crown Lands; and the late Secretary of the Admiralty, Mr. Charles Wood, was very much of the same opinion, and took an interest in the matter; I think the names of the Commissioners were being considered when the late Ministry went out.

2810. Do we understand you to state that pending this disputed ownership, the navigation of the Thames is neglected, and its commerce interrupted?—I consider it to be impeded very much, both above and below London Bridge, as respects improving it.

2811. You consider that under proper authority the river might be cleared from London Bridge down to Gravesend, so as to have 12 feet water at the lowest tide?—Yes.

2812. You see no difficulty in that?—No. No engineering difficulty.

2813. (*Capt. Washington.*) On your professional visits to Whitby last year, in company with the Admiralty Surveyor, did you not find that rubbish was commonly thrown behind the west piers, and was washed into the harbour by the flood tide?—I have stated that circumstance in my Report, to which I would refer the Commission. (*See Appendix*, p. 179.)

2814. Were not complaints also made of ballast being thrown into the harbour with impunity?—Not with entire impunity; the offenders were brought before the local authorities, and I believe threatened or admonished.

2815. Had you any evidence that that was done?—Yes; I stated that fully in my Report.

[*The Witness withdrew.*]

William English, examined.

2816. (*Chairman.*) What is your profession and place of residence?—I am partner in the firm of Hunter and English, millwrights, and contractors for dredging, &c.

2817. Have you been engaged in dredging the river Thames?—Yes; several parts of it.

2818. Are you now engaged on the Whiting shoal in Limehouse reach?—Yes.

2819. Can you give the Commission any data as to the cost of the dredging of the river generally?—The cost at present of dredging of the Whiting shoal is 1*s*. a-yard; we do not come to the solid stone, as we get to the depth wanted generally before we come to stone.

2820. Have you any rock in that part of the river?—Yes.

2821. What kind of rock?—Concrete, or plum-pudding stone, and solid stone.

2822. Taking the common shingle, can you give any notion of the expense of raising that per ton?—We put common shingle into barges at 5*d*. per cubic yard; the yard contains about 26 cwt.

2823. Do you deliver it also for that?—No, we only put it into barges for that; there is the lighterage, and the landing besides.

2824. How much would that come to?—It depends upon the distance to which it is taken. All the shingle we get is taken from above London Bridge; when we carry it down below, we pay to some parts 9*d*. and to some parts 1*s*. for the lighterage, and only 5*d*. for the raising, that is, 1*s*. 5*d*. per yard to take it down as low as Bow creek.

2825. Why are you not allowed to raise any below London Bridge?—On account of the Trinity House requiring a supply for the ballast of the vessels for themselves.

2826. Have you much demand for shingle?—In the middle of the summer there is great demand for it for the foundations of buildings.

2827. Do you sell it in that case?—Yes.

2828. Does the sale pay for the raising of it?—Yes.

2829. You are aware what price is charged for ballast by the Trinity Board?—No.

2830. Do you sell it for more than 1*s*. per ton above bridge?—If we do not do the lighterage, we sell it at 5*d*. per yard; if we take it down as low as Bow creek it is then 1*s*. 5*d*. per yard.

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2831. Are you much employed above London Bridge?—Principally employed above London Bridge.

2832. Do you raise anything but shingle?—No; we cannot sell it if we do.

2833. Are there many parts and shallows where there is mud and peat, and matter that you cannot sell?—A great many.

2834. Suppose you were employed to clear the river from London Bridge upwards, so as to make a fixed depth at low water, taking a certain portion of the bed out regularly from side to side, what would be the expense you could raise it for; supposing you were called upon to remove it altogether for what sum could you do it, including lighterage and everything?—I cannot answer that question without I knew where we could deposit it, because if we had a long way to take it, there is so much more lighterage.

2835. Are the Commission to understand that now when you dredge above London Bridge you do so by permission from the Lord Mayor?—Yes.

2836. Do you confine your dredging entirely to raising gravel such as you can sell?—Entirely.

2837. Have you no directions given you to dredge in the shallowest places so as to form a channel in the middle?—We have this direction given to us, that we are not to go within such a distance of the shore; we are not to go nearer than 100 feet of the shore each side. We apply to the water bailiff when we find we cannot dispose of the part where we are at work, and ask permission to remove to another place, pointing out where we wish to remove to, and he generally gives us leave.

2838. In no case do you remove silt or clay, or anything that you cannot sell?—No.

2839. Would there be any difficulty in making the bed of the river from Westminster Bridge downwards to London Bridge 5 or 6 feet deep at low-water all the way?—There would be no difficulty at all in doing it.

2840. Do you know what water there is at London Bridge at low-water now?—I do not. We did deepen at London Bridge at the request of the city, and took a good deal away.

2841. Of shingle?—No, it was principally Kentish rag that had been thrown overboard.

2842. Are the Commission to understand that all the dredging now is more for the material you want, than with a view to deepening and keeping the channel regular?—It is.

2843. Is it not a private speculation?—Yes. Where we are now employed at Whiting shoal the City pay us for it. The Trinity Corporation claim all that is fit for ballast, and they take it away; we put it in their craft.

2844. Do they pay you anything for putting it in their craft?—The City pay us.

2845. Do the Trinity Corporation take that for nothing which is raised at the expense of the City?—I believe so, but I am not certain.

2846. If it were desired to clear the river in the way that has been stated, and according to the plan of Mr. Walker, is there any difficulty in doing it except the expense?—Not that I am aware of, except at such places as Whiting shoal, where there is concrete and solid stone from 2 inches to 4 inches thick, and gravel, which creates some difficulty.

2847. Is there any other spot in the river where you think there is similar concrete?—Not that I am aware of. We meet with it, but it is thin above bridge, and we are able to tear it up.

2848. What is the power of your dredging-machines?—We have two dredging-machines of 10-horse each.

2849. What quantity could you raise in a day?—Of shingle and gravel we can load about 40 tons in half an hour with each machine.

2850. How many hours in a day can you work with your dredging-machines?—Ten hours.

2851. In that time how many tons could you raise?—600 tons. We can raise 40 tons in half an hour, but it takes some time to take one barge away when loaded, and to put another in.

2852. (*Capt. Washington.*) Does it take half an hour to do that?—A quarter of an hour on an average.

2853. Do you average 60 tons an hour throughout the day with each engine?—Yes, when it is gravel, and there is demand for it.

2854. You know the Trinity Board ballast-engines?—Yes.

2855. (*Chairman.*) What power are they?—20-horse each.

2856. How many of such engines have they?—Two; we only work two ladders, and they work four ladders.

2857. (*Capt. Washington.*) Suppose you were dredging the Thames in the way recommended in Mr. Walker's Report, how many engines would you use, and how soon do you think you could get the work done?—It would depend on the quantity, it would take several machines.

2858. (*Chairman.*) Supposing the quantity of cubic yards of soil to be removed from London Bridge down to Gravesend should be 1,200,000, how long would you be in removing that?—Four years, with two machines of 24-horse power each.

2859. (*Capt. Washington.*) What is the engine you have now got on the Whiting shoal?—One of 10-horse power.

2860. (*Chairman.*) What depth below low water are you engaged to remove Whiting shoal?—Fifteen feet below average low water.

2861. How do you fix the low-water mark?—There is a mark on the shore put up by the Navigation Committee, which goes up from one to so many feet; then we mark what we call our ladder, and look at the mark on the shore what depth to work the ladder to.

2862. What is the depth of the shoal you have gone through?—Where we are now we are not taking off more than three feet.

2863. What is the largest depth of shoal you have taken off?—In some places I think about five feet.

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2864. What strata did you find?—The first stratum we find is gravel.

2865. How deep?—I suppose in some cases not more than six inches; after that clay, and that part is about 18 inches or 2 feet, then we come to a substance between a clay and a stone, and then we come to the stone.

2866. The stone is at the depth of about four feet below the bed of the river?—In different places there is more on the stone than four feet.

2867. What is the thickness of the concrete?—About six inches; when we get to the depth we leave off.

2868. What have you left off in?—We leave off generally in clay.

2869. To what extent is that shoal; how far does it extend?—I do not know the width of it; there is deep water on the further side, but not on this side. We are making a cut now, and intend to make a second cut of 150 feet wide the whole length.

2870. You mean a second cut from the side?—Yes, we are making a channel of about 150 feet.

2871. How long is the shoal?—From Blackett's Dock to near the end of the City Canal.

2872. How far is that?—About half a mile.

2873. Of all the dredging you have had in the river, is that shoal the hardest and most difficult?—Yes.

2874. How high up the river have you used your dredges?—As high as Wandsworth.

2875. Have you invariably found gravel?—Yes; but in some parts little gravel, and mixed with clay: it will not do for concrete, therefore we cannot sell it, and leave it.

2876. Do you mean that the gravel being mixed with clay and mud, it does not answer the purpose you want it for?—Yes.

2877. And therefore you do not raise it?—We do not raise it, and we then ask for leave to remove to another part.

2878. Your object being to obtain the article, and not with a view of deepening the channel?—Just so.

2879. You see no difficulty, if it was requisite, in deepening the whole river from London Bridge upwards to Wandsworth, so as to make it navigable?—No difficulty, except that in some parts there is very little gravel, and we come to clay, then it would be a higher expense, but still it can be done.

2880. Are there no limits fixed as to the depth you may go in search of gravel?—Yes, 10 feet below low-water mark, when we are not working near any bridge, but formerly I have dredged at 27 feet in some parts.

2881. The water-bailiff, then, is the person who gives you liberty, and fixes the place where you are to go?—Yes; when we find we cannot dispose of it, we apply to him to allow us to remove to another part, and mention the place where we wish to move to, and we generally obtain leave to do so, if it is not near any bridge.

[*The Witness withdrew.*]

Adjourned.

APPENDIX.

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APPENDIX.

APPENDIX.
No. 1.

No. 1.

Extracts from the Votes of the House of Commons.

20th June, 1844, *page* 1246.

8. Harbours, &c.—Return of the several dues and charges of every kind levied on shipping at each port, harbour, or creek, in the United Kingdom; stating the rates of the several dues levied per ton on each vessel, and whether under authority of Acts of Parliament, and what Acts; whether by orders of municipal corporations, and of what date, or whether by charter, consent, prescription, or any other authority; so as to exhibit the entire charges of every kind on vessels at each of the harbours, ports, and creeks of the United Kingdom; distinguishing the several charges upon vessels taking refuge in the harbour only, from those upon vessels delivering the cargo, in whole or in part; and also on vessels in the coasting or in the foreign trade; distinguishing also the charges levied for local lights and beacons in each port (exclusive of those of the Trinity House, the Irish Ballast Board, and the Commissioners of Northern Lights), the charges for pilotage into and out of each harbour, and the charge for ballast; and whether under any and what Board the same are levied.—(Mr. *Hume.*)

16th July, 1844, *page* 1508.

22. Harbours, &c.—Petition of *Patrick Stead*, for inquiry into the constitution and qualification of the Commissioners of the Navigations and Harbours in the United Kingdom, as well as the state of the Tidal Harbours; to lie on the table.

23. Harbours, &c.—Address to Her Majesty, "that she will be graciously pleased to appoint a Commission to inquire into the past and present condition of the several tidal harbours, ports, and creeks of the United Kingdom, with the view of ascertaining the state of the navigation and the depth of water of these harbours, &c.; whether the depth of water was greater formerly than at the present time, and whether any and what extent of land over which the tide flowed at any former period has been inclosed; under what authority the several inclosures were made, the effects of such inclosures of land and of the erection of piers, jetties, &c., in decreasing the depth, or in improving or injuring the navigation of the several harbours, creeks, &c.; to call for and examine all general Reports of Civil Engineers and public Commissioners relative to the construction, improvement, or preservation of the several ports, harbours, creeks, and navigable waters of the United Kingdom which have been regulated by Act of Parliament since 1800, the operations under such Acts, and whether the result has been beneficial or injurious to the navigation of the said ports: also to inquire into the nature of the powers entrusted to the Board of Admiralty, under any Acts of Parliament, for protecting the navigation of the ports and harbours of the United Kingdom, and in what manner they have exercised those powers; and whether more extensive and more defined powers may be requisite to enable them to protect and to improve the harbours of this kingdom."—(Mr. *Hume.*)

29th July, 1844, *page* 1646.

38. Harbours.—Address for "Copy of the receipt of every harbour in the United Kingdom, for each of the last three years, stating the several heads of income, the authority by which the same are levied; and of the expenditure for each of the same years, stating the several heads of expenditure, and the amount of each head in each of those years."—(Mr. *Hume.*)

9th August, 1844, *page* 1748.

44. Harbours.—Address for "Return, by the Commissioners appointed under the several Acts of Parliament relating to the harbours and havens in the United Kingdom, stating the titles of the several Acts of Parliament, or Charters and Commissions, under which they have acted and now act; also copies of all maps of the harbour or port in their possession, and of all Reports made by engineers or other officers respecting the port or harbour; together with copies of complaints made to the Commissioners of the several harbours and ports of the defects of the harbours."—(Mr. *Hume.*)

No. 2.

No. 2.

Extract from a Report made to the Navy Board by a Committee of its Members appointed to inquire into the State of the River Medway.

"*Chatham Dockyard*, 10*th May*, 1818.

"We cannot therefore conclude without expressing a strong opinion that every encroachment upon a public harbour, however trifling it may be represented, should be viewed with the greatest jealousy; and seeing the injury occasioned in different harbours by apparently small encroachments, we think it highly worthy of consideration, whether it may not be desirable to revise and consolidate the several Acts of Parliament for the preservation and improvement of the royal harbours and rivers, and to invest certain of His Majesty's officers, resident in the vicinity of the harbours and rivers, with a power to prevent any such encroachments; and that the proprietors of the lands adjoining, or others, should be made liable to a fine, upon proof, before any magistrate, of having made or added to any hard, causeway, or other obstruction, without the permission of officers so empowered; but the details of any such regulations may be made a subject of future consideration.

(Signed) "T. Byam Martin, Rear-Admiral,
Robert Barlow,
Robert Seppings,
} *Commissioners of the Navy.*"

APPENDIX.

No. 3.

No. 3.

Extract from Mr. Bald's Papers on the Rise of the Tide, and the time of Ebbing and Flowing in the River Clyde.

SPRING TIDES.

The mean result of six observations, taken on the 18th, 19th, and 20th March, 1840, of the rise and fall of the tide at the following places, was as follows (full moon 18th March):—

	Hours.	Minutes.	Feet.	Inches.
Mean rise and fall of six tides in the harbour of Glasgow			8	4
Ditto at Clyde Bank, 5 miles 866 yards from Glasgow Bridge			8	0
Ditto at Bowling Bay, 10 miles 1166 yards from ditto			8	9
Ditto, 18 miles 1166 yards from ditto			10	5
Mean time of flowing in Glasgow Harbour	5	10		
Ditto of ebbing in ditto	7	13		
Mean time of flowing at Clyde Bank	5	15		
Ditto of ebbing at ditto	7	6		
Mean time of flowing at Bowling Bay	5	24		
Ditto of ebbing at ditto	6	56		
Mean time of flowing at Port Glasgow	6	6		
Ditto of ebbing at ditto	6	1		

NEAP TIDES,

Taken at the following places on the 25th, 26th, and 27th March, 1840.

	Hours.	Minutes.		
Mean result of six observations of the rise and fall of the tide in the harbour of Glasgow			6	3
At Clyde Bank, mean of six tides			5	10
At Bowling, ditto			5	11
At Port Glasgow, ditto			6	1
Mean time of flowing at Glasgow	5	14		
Ditto of ebbing at ditto	7	16		
Mean time of flowing at Clyde Bank	5	43		
Ditto of ebbing at ditto	7	1		
Mean time of flowing at Bowling	5	52		
Ditto of ebbing at ditto	6	37		
Mean time of flowing at Port Glasgow	6	26		
Ditto of ebbing at ditto	5	59		

Extracts from Mr. Bald's Report on the Velocity of the Water in the River Clyde.

"The mean velocity of four sets of observations of the water passing down the Clyde, from the Harbour of Glasgow to the Junction of the Cart River with the Clyde, in ordinary fair weather may be taken at 1576 yards per hour, and the ascending current at 771 yards per hour; and from the Junction of the River Cart with the Clyde, to opposite Dumbarton Castle, the mean of five observations assigns the descending velocity of the Clyde at 1 mile 1069 yards per hour, and the ascending current at 1561 yards per hour.

"I have tabulated nine sets of observations of the velocities of the ascending and descending tidal and river current, from Glasgow Bridge to opposite Dumbarton Castle, a distance of 13 miles and 11[illegible] yards, as follows:—

	Ascending Tidal Velocity per Hour, in Feet.	Descending River Velocity per Hour, in Feet.	Distance below Glasgow Bridge, in Yards.	Distance below Glasgow Bridge, in Miles and Yards.	
				Miles.	Yds.
From Junction of the River Cart with the River Clyde to opposite Dumbarton Castle:—					
Opposite Dumbarton Castle . .	3,525	8,677	24,000	13	1120
,, Dunglass Castle . . .	5,564	8,743	19,830	11	470
,, Donald's Quay . . .	6,866	8,828	17,333	9	1493
,, Rushalee Pier . . .	3,272	7,200	15,000	8	920
,, Centre of Newshot Isle .	4,200	9,000	13,000	7	680
One-fifth . .	23,427	42,448			
One-third . .	4,685	8,489			
	1,561 yards.	2,829 yards.			
From Junction of the River Cart with the River Clyde to the harbour of Glasgow:—					
1000 yards above the embouchure of the River Cart with the Clyde	3,600	6,000	10,333	5	1533
Opposite Scotstoun House . . .	1,600	5,142	8,000	4	960
200 yards below Crawford's Quay.	3,000	4,500	5,000	2	1480
600 yards above the embouchure of the River Kelvin with the Clyde	1,058	3,272	3,166	1	1406
One-fourth . .	9,258	18,914			
One-third . .	2,314	4,728			
	771 yards.	1,576 yards.			

"In the River Clyde during high floods, immediately below the harbour of Glasgow, I have found the velocities of the descending currents run at the rate of 2 miles 1613 yards per hour; and in the narrow parts of the river 3 miles 1148 yards per hour; this was in the middle of the river, and at the water's surface."

No. 4.

No. 4.

COPY of a LETTER addressed to Mr. JAMES WALKER, Engineer.

Office of the Engineer of the Clyde,
Glasgow, 16, *Robertson Street*, *October* 26, 1839.

DEAR SIR,

YOUR letter of the 24th instant I have received, and I now send you a perfect copy of the plan of the river Clyde improvement proposed by you on the morning previous to your departure from Glasgow, and on which the harbour lines are 450 feet in width down to the Kelvin, and narrowing at that point to 400 feet in width; and then continuing that width to near Renfrew Ferry, from which point it widens below.

The original plan is so covered with figures and lines, and some memoranda connected with the proceedings, that it has been thought better to retain it here, and to send you an exact copy, which the chairman has examined, and is satisfied that it is correct; you will perceive, by comparing the plans, that the one which the Committee have approved of has its lines laid out in such a manner as to save expense, both in cutting and in the purchase of land; and that one of its distinguishing features is that no part of the river channel of the Clyde shall be filled up, which will reduce the estimate of expense; and although the Committee have agreed to those lines and plan as being the best, they can hereafter, if it be judged proper, make the Clyde more direct in its course if found expedient to do so; power being proposed to be taken to the extent of   yards on each side for this purpose.

In your letter of the 24th instant you mention "I have looked at the plan just sent, and with a trifling increase of the width which, as Mr. Turner informs me, the Committee have directed you to make, I cannot yet discover any difference between the plan now sent and the lines I laid down when in Glasgow without reference to any plan of yours."

I beg to say that the plan which I sent you with the lines delineated on it by me, and unanimously approved of by the Committee on the 16th and 18th instant, is quite different from the plan which you had designed and laid out when in Glasgow on the 12th instant, and which plan of yours was 450 feet wide from the harbour down to the Kelvin, at which point it was to be only 400 feet wide, and then to continue the same width to very near Renfrew. This plan of yours was peculiarly marked, and altogether different from any other plan that I had yet seen or heard of for improving the Clyde or any other tidal river; being a wide cylinder above and a narrow one below, a form calculated to prevent the tidal flow up the Clyde, which, in my opinion, would be highly injurious to the navigation, and the plan is characterized by proposing that several parts of the channel of the Clyde shall be filled up, and some large portions of ground cut away, and which I think was quite unnecessary. Mr.

APPENDIX.
No. 4.

Logan's plan from the harbour down to near Renfrew was of an equal width, and it also proposed that several deep and large parts of the present channel of the Clyde should be filled up. But the plan sent to you on the 19th instant, and which had been unanimously approved of by the Committee was quite different from either your plan or that of Mr. Logan's, having a gradual increase of width from the harbour to the Cart, a form peculiarly favourable to a tidal flow up the Clyde; and it does not propose that any portion of the channel of the Clyde shall be filled up, or any large portions of ground adjacent to it be cut away for an increased width, when such can be avoided by substituting easy bends in place of nearly direct lines. These, in my opinion, are the points in which the merits of the plan consists, and which will insure its success through the Houses of Parliament if it should be opposed, because its form and shape can be defended by the laws of science; and also by those configurations which nature has universally assigned to every tidal river in the world. Whereas the plan of widening a tidal river above and narrowing it below would be the very cause of its failure in Parliament if opposed, were the design even to carry the illustrious names of Smeaton and Rennie. The plan for the improvement of the navigation of the Clyde must stand on its own merits if a contest takes place, for nothing else can sustain it or insure its success, although a different opinion is expressed on this subject.

With regard to the channel on the south side of the Newshot Isle, to which you have alluded in your letter, I have to express my very deep regret of any objection having been offered to its investigation as to whether or not rock exists in a small portion of its channel, because, until this is decided, I entertain a strong and a decided conviction, that it is not only the shortest, but in every point of view the best channel for the navigation of the river Clyde; and particularly so, as being much more favourable than the northern channel to receive and send up the full tidal flow; a scouring power, on which the preservation of the navigable channel of the Clyde will have chiefly to depend when it has been widened and deepened to the dimensions required. There is no engineering project which I have yet met with that I entertain so serious an idea of its being carried into execution than the opening of the channel on the south side of the Newshot Isle. Nor is there one improvement in the whole range of the river Clyde, more worthy of the attention and consideration of the engineer, or one that would be more useful in improving the navigable channel, and the tidal flow upwards, although you have, I think, without sufficient grounds, ventured to express yourself decidedly against it.

In concluding, I must assure you that my most earnest wish and only object is, that the best plan shall be adopted for the improvement of the Clyde, and that it may be one whereby all its capabilities may be fully developed, so as to afford every facility and accommodation to the rapidly increasing maritime prosperity of the port of this city.

The plan drawn out by me and approved by the Committee on the 16th and 18th instant, cannot be claimed by you, because it was the work of others, planned and made out after you had left Glasgow, and on a principle entirely different from anything you had recommended or even suggested.

I am, Sir,
Your obedient Servant,
WILLIAM BALD.

James Walker, Esq.
23, *Great George Street, Westminster, London.*

No. 5.

No. 5.

Extract from Mr. Bald's Papers of the performance of the Steam Dredging Boats in the River Clyde and Harbour of Glasgow.

The following statements have been taken from the official records of the Clyde trustees. But no account can be found in their books of the annual quantities of material which had been dredged up in the harbour of Glasgow and the Clyde previous to 1838, and which was one year before Mr. Bald was appointed engineer:—

Firstly. It is proposed to show the increased quantity which the four dredgers had dug up from the Clyde in 1839, 1840, and 1841, by manual labour, as compared to the quantity which had been dredged up by the same four dredgers in 1838, the year before Mr. Bald's appointment.

Secondly. The quantity which had been dredged up by the same four dredgers in 1842, 1843, and 1844, by the application of the propelling power as compared to 1838.

Thirdly. The quantity which steam-dredge No. 5 lifted in 1842, 1843, and 1844, when the propelling power was applied, compared to the quantity which she would have lifted by manual labour in the same time, deduced from the element of No. 5 dredge-boat's performance during the period of 30 weeks which she had been worked by manual labour in 1841.

Fourthly. The total quantities which have been dredged up by dredge-boats No. 1, 2, 3, 4, and 5, in the years 1838, 1839, 1840, 1841, 1842, 1843, and 1844.

Firstly. By manual labour there were dredged up the following quantities by dredge-boats Nos. 1, 2, 3, and 4.

In 1838	Dredged up	13,540 Punt Loads.	
1839	,,	14,217 . . .	677
1840	,,	19,516 . . .	5,976
1841	,,	18,443 . . .	4,903
Total Increase by Manual Labour .			11,556 Punt Loads.

Carried forward . . . Punt Loads 11,556.

Brought forward . . . . . . Punt Loads 11,556

Secondly. By the propelling power No. 1, 2, 3, and 4, dredgers lifted.

		Quantity raised in 1838 by Manual Labour.	Increase.
	Punt Loads.	Punt Loads.	Punt Loads.
In 1842 . .	22,449	13,540	8,909
1843 . .	21,938	13,540	8,398
1844 . .	23,895	13,540	10,355

Total Increase by the Propelling Power . 27,662 Punt Loads. . 27,662

Thirdly. In order to arrive at the performance of No. 5, it may be observed that she began to work in the end of May, 1841, and stopped the 25th December, being 30 weeks, during which period she raised 3438 punt loads, and was worked by manual labour

In 1842, 1843, and 1844, she raised the following quantities in the following periods by the propelling power of machinery :—

	Manual Labour.			Propelling Power.	
	Punt Loads.	Weeks.		Punt Loads.	Weeks.
1841	3,438	30	1842	8,832	46
			1843	7,506	40
			1844	6,683	42
	3,438	30		23,021	128

It appears that No. 5 in 1841 worked 30 weeks, and lifted by manual labour 3438 punt loads; and during the years 1842, 1843, and 1844, she worked 128 weeks, and would consequently, in the same ratio, have lifted by manual labour (30 : 3438 :: 128= 14668) 14,668 punt loads; which, taken from 23,021 punt loads which she actually lifted by the propelling power in 128 weeks, leaves an increase of 8353 punt loads . . . 8,353

47,571

Fourthly. Quantities lifted by Nos. 1, 2, 3, 4, and 5 dredging-boats.

Manual Labour.

	Punt Loads.	Punt Loads.	Punt Loads.
In 1838 Four Boats lifted	13,540		
1839 ,, ,, ...		14,217	
1840 ,, ,, ...		19,516	
1841 Five Boats ,, ...		21,881	
			55,614

Steam Propelling Power.

	Punt Loads.	Punt Loads.	Punt Loads.
1842 Five Boats lifted		31,281	
1843 ,, ,, ...		29,444	
1844 ,, ,, ...		30,578	
			91,303
Total			146,917

The above statement shows that *five boats* using the propelling power dredged up during each of the years 1842, 1843, and 1844 more than double the quantity that *four boats* dredged up in 1838 by manual labour.

	Punt Loads.
The first statement shows an increase by four dredges in 1839, 1840, and 1841, as compared to 1838 working by manual labour, of	11,556
Second statement shows an increase by four dredges in 1842, 1843, and 1844, as compared to 1838, working by the propelling power of . .	27,662
Third statement shows that No. 5 had obtained an increase of 8353 punt loads working by the propelling power, as compared to the amount of her duty performed by manual labour of	8,353
Total increase	47,571

47,571 punt loads of additional material has been dredged up from the bottom of the harbour of Glasgow and the river Clyde, in working the steam-dredges during the years 1839, 1840, 1841, 1842, 1843, and 1844, as compared to the performance of steam-dredges Nos. 1, 2, 3, and 4, in 1838.

The machinery fitted up and placed by Mr. Bald in the steam-dredges in 1842, to move them forward by the power of the engines instead of manual labour, is of the simplest kind, and not liable to derangement. There are four pair of mitre wheels, and three pair of spur wheels, for altering the different speeds. The power is applied by a 6-inch leather belt, wrought by a pulley attached to the fly-wheel, and works in a most effective manner.

U 2

APPENDIX.

No. 5.

EXTRACT from Mr. BALD'S PAPERS, showing the AMOUNT of the PERFORMANCE of the LABOURING FORCE, and time of the FIVE STEAM DREDGE BOATS on the RIVER CLYDE, by MANUAL LABOUR, PROPELLING FORWARD, and also by STEAM POWER, PROPELLING FORWARD.

BY MANUAL LABOUR, WORKING FORWARD.

	Dredge No. 1.		Dredge No. 2.		Dredge No. 3.		Dredge No. 4.		Dredge No. 5.	
	Weeks.	Punt Loads.	Weeks.	Punt Loads.	Weeks	Punt Loads.	Weeks.	Punt Loads.	Weeks.	Punt Loads.
1838	28	2,268	34	3,075	30	2,746	38	5,451	..	..
1839	38	3,366	38	3,312	50	3,538	42	4,001	..	..
1840	28	2,433	44	5,069	46	6,169	46	5,845	..	..
1841	50	5,354	46	3,307	40	4,894	42	4,888	30	3,438

BY STEAM POWER, WORKING FORWARD.

	Weeks.	Punt Loads.	Weeks.	Punt Loads.	Weeks	Punt Loads.	Weeks.	Punt Loads.	Weeks.	Punt Loads.
1842	40	4,740	28	4,469	46	6,090	46	7,150	46	8,832
1843	38	4,957	44	4,965	40	4,768	44	7,248	40	7,506
1844	42	5,483	46	8,191	32	4,504	38	5,717	42	6,683

No. 6.

No. 6.

TOTAL AMOUNT of EXCAVATION dredged from the bottom of River Clyde and Harbour of Glasgow in the following Years.

No. of Dredge Boat.	In 1838.	In 1839.	In 1840.	In 1841.	In 1842.	In 1843.	In 1844.
	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.	Punt Loads.
No. 1 .	2,268	3,366	2,433	5,354	4,740	4,957	5,483
2 .	3,075	3,312	5,069	3,307	4,469	4,965	8,191
3 .	2,746	3,538	6,169	4,894	6,090	4,768	4,504
4 .	5,451	4,001	5,845	4,888	7,150	7,248	5,717
	13,540	14,217	19,516	18,443	22,449	21,938	23,895
5 .	..	..	..	3,438	8,832	7,506	6,683
Totals .	13,540	14,217	19,516	21,881	31,281	29,444	30,578
Excavation in Upper Harbour, per Contract							1,188
Total quantity excavated 161,645 Punt Loads, from the beginning of 1838 to the end of 1844 A punt load is about 10 cubic yards, or 13 tons							31,766

No. 7.

No. 7.

SIR,

Rouen, 16*th April*, 1845.

BEING informed that you are the engineer for the River Clyde, and being desirous of getting some information from your country on a subject which we know to have met success with you, and which now greatly occupies our minds here, I beg leave to address you about it, and shall feel particularly obliged for any answer you will have the goodness to give me on the matter. I mean the improvement of rivers, the outfall of which is obstructed by moving sands, as it is the case with our large River Seine.

Not doubting but you may have at least some general knowledge of it, I scarcely need mention that on either side of the mouth there are two out harbours or ports; the one Havre, the other Honfleur. Their interval (about 10 or 12 miles) is greatly impeded by several shoals, some of shingle, some of sand, carried in by the flowing tides; some fixed, some moving, according to the strength of the ebbing tides, and of the winds. But, however injurious this may be, the there existing struggle between the said two opposite powers is considered as the origin of a very important propriety for the port of Havre, viz., to keep its high water about one hour and a-half after the tide is fully risen. It is also a prevailing opinion there that the very large space in the mouth of the river is necessary for receiving the sands or stones coming from sea long side of the coast, and that any alteration that could be made to that mouth might endanger the safety of Havre under both above points of view.

The said shoals extend nearly 30 miles upwards in the river, and the channel or stream of the inland waters will change their course at almost every spring tide, and be divided in many small channels, either of which want sufficient depth, so that at neap tides, almost no vessels can pass, and at spring tides no larger vessels than 10 or 12 feet deep can get up.

The borders of the river will offer large expanses of area covered by the flowing tides.

It is a general belief that the said shoals, or accumulations of sand or silt, brought down also from the interior, by their making a kind of natural weir at sundry places across the river, and thus retarding the ebbing tides, greatly contribute to the preservation of a greater depth of water in the upper part of the river, and that in case of their being removed, a great alteration of its present level might take place upwards.

Now however we are going towards some trials for improvements of this river, that should consist in deepening it by contracting the banks to a reasonable width, and preventing the river to spread widely as it used to do, always allowing the free course of the tide, &c. But even these works, though limited at first to the upper part of the river, are opposed by many people as being capable of producing both the bad effects above alluded to, viz., to alter the course and rules of the waters below, so as to injure the good proprietary of the port of Havre, and at the same time to be not less obnoxious to the port of Rouen by diminishing the depth of its waters.

Of course such objections, if grounded, ought to deserve a great deal of attention; but while our most eminent engineers are divided of opinion amongst all their theoretical knowledge, we, but common people, should wish to know whether there be not in England some well known plans where works of the same kind, under nearly similar circumstances, might have been executed without bringing forth all the dreadful effects which are now prophetized to us. We have much heard of the Clyde, as having well succeeded; of the Mersey (but we do not know whether any thing was brought to a conclusion there, or whether it remained to a mere state of project); of the Ouse, of the Severn, &c.; but we know extremely little, with a sufficient accuracy, of what may exist or not exist as for any analogy between those places, their conditions, the constitutions of their rivers and ours.

Please, therefore, to tell me (if you can do so without too much trouble) what may be your opinion upon the whole, and particularly at what places you should think that some such enterprizes having succeeded, might be consulted as a sort of guidance and authority in any actual discussion of ours.

Be so good as to excuse my intruding upon you, being totally unknown, and believe me, very respectfully,

Sir, your obedient, humble Servant,

J. RONDEAUX,
President of the Chamber of Commerce at Rouen.

Mr. Bald, Engineer for the River Clyde.

Glasgow, Office of the Engineer of the Clyde, March, 1845.

SIR,

I HAVE received your letter of the 12th instant, and do regret exceedingly that I have not been able to answer it sooner; but in reply I have only to say, that I shall be delighted to give you any advice or assistance in my power regarding the improvement of the navigation of the River Seine and Ports of Havre and Honfleur.

I have seen your river Seine, but it is 19 years ago, and I have not been in France since 1831; but, nevertheless, reading your letter carefully over, I can readily understand what your objects are.

All the celebrated engineers of this country,—Smeaton, Rennie, Telford, Nimmo, &c., have all concurred in opinion that the improvement of tidal rivers for navigable purposes depends upon obtaining a greater flow and a greater quantity of tidal water upwards into them. Now, this principle being admitted, it is manifest that all obstructions to the tidal flow upwards should be removed, such as shoals, bars, &c; and that all means should be adopted to increase the quantity of tidal water into all the higher and upper reaches of tidal rivers. This will give a greater scouring power to keep the navigable channel free from shoals; but it may also considerably deepen and improve it. Besides, if there are any bars or shoals at the mouth of a tidal river, their removal can best be achieved by obtaining and procuring a larger quantity of additional tidal water up into the higher reaches of the river.

Now, you state that it is proposed to deepen the river Seine by contracting its banks, and to prevent the water of the river from spreading so widely as it used to do; and that this operation is to be limited at first to the upper part of the river, always allowing the free course of the tide, &c.

I really do not see how you can contract the banks of any river so as to prevent the water spreading, without in some measure intercepting the tidal flow. I should be wanting in duty if I did not warn you, on no account to give the least obstruction to the tidal waters upwards by narrowing the banks of the river, or by the construction of dykes. To achieve this important object requires much careful consideration and great reflection in the construction of the works; because, if you shall in any measure diminish the tidal flow upwards into the highest recesses of the Seine, you will lessen your tidal scour outwards, and in all likelihood diminish the depth of water at the mouth of your river, and also at your ports of Havre and Honfleur. My advice is, to try and carry the tidal waters as high up as possible into the upper recesses of the Seine, and to be cautious and careful how you narrow the river. I am not able to convey to you all my ideas regarding this great and important improvement for France; because I am not in possession of many details connected with the speed and volumes of the fresh and salt water ascending and descending, the nature of the bottom, soil, tides, &c. &c.; nor am I in possession of any detailed plans to enable me to arrive at anything definite on this interesting subject: but, nevertheless, I am strongly impressed with the idea, from my recollection of the Seine, that a great improvement could be effected as regards its navigation.

I am not able to refer you to any river in Europe where so much has been done as in the Clyde in improving a tidal river navigation; in 1755 the River Clyde could only float vessels drawing three feet six inches of water; now the River Clyde can float vessels drawing eighteen feet of water, notwithstanding the many errors which have been committed in improving it during the ninety years it has been under the hands of the engineer. And I really do not see why you should not, with care and attention in the construction of works, attain a depth of 20 feet of water instead of 10 or 12 feet, as you mention; and that fleets of both merchantmen and also of men of war should be able to obtain perfect shelter and security within the embouchure of the River Seine.

I shall be very glad to hear from you, and it is very likely that I shall be shortly in London, and also perhaps in France, and should be very glad to examine your projects of improvement in passing on my way from Havre to Paris, and render you every service in my power, and give you all my ideas when I shall see the plans and charts of the River Seine. I again take the liberty to caution you that

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any works which shall be proposed for the deepening of the navigation of the Seine should be carefully considered, because a great deal has been done on this River Clyde which must be undone at a great expense; errors of the gravest kind have been committed, notwithstanding the great success in deepening it, and this depth is now only preserved by an annual dredging of about 180,000 *cubic yards* of deposit on a river line of 18 miles long. Now the great object should be to get the tidal scour, to preserve the depth, and save this great annual expenditure; therefore the operations of nature should everywhere be assisted in deepening by the aid of works which have been found to be successful.

I am Sir, with great respect,
Your obedient Servant,
(Signed) WILLIAM BALD.

à Monsieur J. Rondeaux, President of the Chamber of Commerce at Rouen.

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No. 8.

Extract from the Appendix of Mr. Bald's Report on Blackstone Moss; addressed to the Clyde Trustees, 23rd September, 1844.

The great and expensive works which have been erected to obtain a back scour of water may be fully appreciated by referring to the artificial reservoirs of water with sluicing gates attached to many of the continental harbours, prove the great benefit which have been derived from the power of water in deepening harbours by back scouring water, and also in afterwards preserving and maintaining the depths obtained.

Indeed the artificial scour through harbours from back water by reservoirs and sluice-gates perform the work of the modern steam dredgers. Those reservoirs and sluice-gates are to be seen at the ports of Nord Catwyck, in Holland; also at Ostend and Dunkirk, in France. The latter harbour was formed by purely artificial means, viz., scouring reservoirs of back water and sluices, and was one of the most successful harbours which the engineers of France had constructed, although the whole of the coast adjacent to the harbour was flooded with immense banks of moving sand, yet by the industry of the engineer it became in time of war one of the most formidable ports upon the whole coast of France to the commerce of England. In 1706 it enjoyed a most flourishing trade, and during the war, which terminated in the Peace of Utrecht, its privateers took 1614 English ships, value 1,334,375*l*. England suffered so much that she would consent to no peace unless the whole harbour and fortifications were destroyed, and the harbour filled up at the expense of France. This clause was inserted in one of the Articles of the Treaty of Utrecht, which was signed on the 28th April, 1713. This was done under the direction of Colonels Armstrong and Clayton. Yet after this Louis XIV. constructed a new canal to Mardyke, by which the harbour was much improved. In 1717 France was again compelled, by a treaty at the Hague, to destroy the harbour. In 1748, by the treaty of Aix-la-Chapelle, Dunkirk harbour was again doomed to be destroyed.

Extract from Mr. Bald's Report, read before the General Meeting of the Clyde Trustees, on Tuesday the 3rd September, 1844.

The improvement of the navigation of the Clyde and the harbour of Glasgow by deepening is principally due to the labouring force of the steam dredgers, and which is attended with a very considerable annual expense. A question has arisen, whether it might not be possible to work them a longer period of time each day, and perform a greater quantity of work.

In order to throw some light on this very interesting subject as regards expenditure, the preservation of the depth of the present navigation and its further improvement, it may be first observed that there are five steam dredgers employed in the deepening operations of the harbour and river; their power and depth of working are as follows:—

No. 1	steam dredge	has an engine	12	horse power	which works in	12	feet depth of water
No. 2	ditto	ditto	16	ditto	ditto	14	ditto.
No. 3	ditto	ditto	16	ditto	ditto	14	ditto.
No. 4	ditto	ditto	20	ditto	ditto	15½	ditto.
No. 5	ditto	ditto	22	ditto	ditto	17 to 19	feet ditto.

Looking at the small depth of water which these steam dredgers work in, with the exception of two of them, and again at the depth in the ship channel of the river Clyde and harbour of Glasgow at high water; and which frequently extends from 15 to 20 feet in depth at lofty tides in gales blowing from south and south west, it must therefore be manifest that there is a very large portion of time each day in which none of these steam dredgers can work, their bucket frames not being able to reach the bottom, and it must be further observed that both the harbour of Glasgow and the river channel of the Clyde are becoming deeper, and consequently lessening the time of working these dredgers.

It has been often asked why do not these steam dredgers work continuously? From what has been stated it must be admitted that this is impossible, and to attain so desirable an object would require steam dredgers capable of working in all depths of water in the harbour and river. There can be no doubt but iron steam dredgers of 30 to 40 horse power, capable of working in depths of more than 20 to 22 feet of water, and each dredger lifting daily more than 100 punt loads, would be much more economical than working the present dredgers, both in the great additional quantity which would be lifted, men employed, fuel consumed, &c., &c. And there would be great facilities to clean out the harbour of Glasgow rapidly. Three such dredgers might lift out of the harbour in 25 good working days (Summer time) 75,000 cubic yards; this would be an object of very great importance, because it is only at certain periods when the harbour is not crowded with vessels that it can be cleaned; and it is for many more reasons desirable that this work should be done very quickly.

I presume that it is now manifest that to achieve continuous working would require a complete change in the greater part of the whole of the trustees' dredgers.

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Looking at these facts, and the present limited working power of these dredgers, I am not aware that much more can be done unless the trustees shall construct two additional iron dredgers, &c., with engines of 30 to 40 horse power each, and capable of working freely in 20 to 22 feet depth of water, as already mentioned, and to sell dredging machines Nos. 1 and 2. This I should strongly recommend, as it would be much more economical than working these old machines, by which so much valuable time and men's labour are lost. This very subject was again brought before the trustees in one of the monthly reports read before them last winter.

Extract of a Letter addressed by Mr. Bald to Mr. David Hope, Chairman of the Committee of Finance, dated London, Trafalgar Hotel, Charing Cross, 5th May, 1840.

I hold it as a principle in all public works, that the clerk who keeps an account of the men's time, should never, on any account, be the individual who pays them. Secondly, that no person connected with the engineer, as foreman or overseer, engaged with the execution of the works, should ever be entrusted with money to pay the workmen and labourers under them; this important duty should be only performed by an individual totally unconnected with all the parties engaged in the executive departments of the works. The foreman of the works, and the clerk who keeps the men's time, should be present when the pay-clerk pays the accounts, and they should witness the payments, and attest the respective pay sheets, by their signature, paid in their presence by the pay-clerk on such a day. This is the principle adopted by the Government in all the public works in Ireland; nor will the Commissioners of Imprest Accounts pass the disbursements of public money, laid out in the execution of public works, upon any other principle.

Engineers' clerks for keeping the workmen's and labourers' time, engineers' foremen, and overseers and engineers themselves, should never have anything whatsoever to do with money, or its payment in any shape or manner.

These are my ideas frankly expressed, and which I before verbally communicated to you.

I am, dear Sir,
Your very faithful servant,
WILLIAM BALD.

A copy of the above letter was sent to the present chairman of the Clyde Trust more than one year ago, but no notice was taken of it, until some irregularities were discovered in making the payments (and which I believe have not yet been adjusted) when the principle of the above letter was obliged to be acted upon, and a total change made in paying the workmen and labourers, but not until after a period of nearly four years had passed.

No. 9.

No. 9.

Bowling Basin.

This basin is situated on the north side of the River Clyde, about 10 miles below the harbour of Glasgow; it encloses a water space of about 14 acres. At the extremity of its western arm a timber wharf has been constructed, about 300 feet in length, alongside of which the largest Indiaman can lie. This basin was commenced in 1841; no plans were ordered to be made of it, nor were any designs laid before the trustees for its execution; a small model was made of the timber work by the late Mr. Robert Bald, and the whole works were completed in one season, so that the large American ships with others were laid up in it during the winter. This basin has given, since its construction, great accommodation to vessels, when the harbour of Glasgow has been crowded. In January, 1844, there were lying in Bowling Basin, 10 square-rigged vessels, 14 steamers, and a great number of other kinds of craft, amounting in the whole to 53; and besides, it has been most useful in affording accommodation to the whole of the Clyde Trustees' dredging vessels diving-bells, punts, &c., &c., and is a most valuable appendage to the port of the city of Glasgow. This work was executed under my direction, without any remit from the trustees; and the zeal and attention of the late chairman, James Hutchison, Esq., to this work during its execution was above all praise, he visited the works once and twice in the week during the fine weather; and indeed bestowed, during the time he was chairman, a very great portion of his time to all the improvements of the river, and frequently went down the Clyde for that purpose.

No. 10.

No. 10.

STEAM DREDGERS.

Extract from Mr. Bald's Details of the Working Operations on the River Clyde.

Number of Boat.	Depth of Working.		Least Depth of Working		Diameter of Cylinder.	Length of Stroke.		Number of Buckets on Frame.	Strokes per Minute.	Length of Frames.		Nominal Power of Engine.
No.	Feet.	In.	Feet.	In.	Inches.	Feet.	In			Feet.	In.	
1	10	6	3	9	21	2	6	31	38	47	9	12 H. P.
2	14	0	4	0	24	2	6	33	38	52	11	16 H. P.
3	14	0	4	0	24	2	6	33	38	52	11	16 H. P.
4	15	6	4	3	26	2	6	34	38	54	7½	20 H. P.
5	17 to 19		4	4	27½	2	6	34	38	58	0	22 H. P.

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Steam-tug, two engines each 30-horse power; diam. of cylinder 30 inches; length of stroke 3 feet 9 inches; strokes per minute 40.

All the steam-dredgers have governors which regulates the speed to about 28 strokes per minute in ordinary working stuff.

Average pressure in boilers about 3½lbs to the square inch.

In general 14 buckets are discharged per minute.

The speed of the buckets on the frames in Nos. 1, 2, 3, and 4, is (3 ft. 5½ in. × 14=48 ft. 5 in.) 48 feet 5 inches per minute

And No. 5 is (3 ft. 8 in. × 14 = 49 ft. 8 in) 49 feet 8 inches per minute.

The larger the engine, the less is the consumption of fuel on board of the dredgers. The small engines are worked to their full power, and consequently consume more fuel in proportion to their power than the larger engines, which are not so much pressed; for example, No. 1 consumes about 18 lbs. of coal per horse-power per hour; while No. 5 only consumes 15½ lbs. per horse-power per hour.

Extracted from Mr. BALD's Details of the WORKING OPERATIONS of DEEPENING and CLEANSING the RIVER CLYDE and the HARBOUR of GLASGOW.

	Amount Expended.			Quantity of Work Executed.	Rate per Cubic Yard.		
	£.	s.	d.	Cubic Yards.	£.	s.	d.
Year ending 25th December, 1841 . .	11,841	18	2	218,810	0	1	1
Year ending 24th December, 1842 . .	13,612	11	3	313,810	0	0	10½
Year ending 23rd December, 1843 . .	9,742	7	6½	294,440	0	0	8
Year ending 21st December, 1844 . .	10,659	3	8	317,660	0	0	8

The expense of dredging and depositing the material taken up from the bed of the river Clyde and the harbour of Glasgow varies considerably, on account of the nature of the material in the bottom, and the distance it has to be carried for deposition.

A punt load may be taken at an average at about 10 cubic yards, or 13 tons.

VALUE OF MACHINERY EMPLOYED ON THE RIVER CLYDE.

	£.	s.	d.
5 deepening machines with engines and gearing .	20,000	0	0
Steam-tug, with two engines each 30-horse power .	3,300	0	0
157 punts	12,560	0	0
13 punts for stones	650	0	0
2 diving-bells	750	0	0
Fifteen additional iron punts amount to about . .	2,025	0	0
Total.	£39,285	0	0

Note attached by Mr. Bald to the Clyde Bank Monthly Accounts of the 9th November, 1844.

As the Clyde Bank accounts were usually before this period, checked in Mr. Spreull's office before being sent into the Engineer's office; Mr. Bald requests the attention of the Committee of Finance to the rate of wages for labourers charged in the Clyde Bank accounts, which is at the rate of two shillings and twopence per day, while the rate of wages paid to the labourers both in the harbour and river is one shilling and tenpence per day. Mr. Bald cannot see on what grounds this anomaly should exist in the Clyde Bank department as regards the pay to the labourers, and which is two shillings per week more than what is paid to the labourers employed on the works of the harbour and river.

Mr. Bald has to state that not the least notice was taken of the above note, nor any rectification made by the Committee of Finance, as to this anomaly in the payment made to the labourers at Clyde Bank.

No. 11.

No. 11.

[Clauses respecting the Glasgow Water-works, referred to in Q. 2365.]

Extract from the Act 6 *Geo. IV., cap.* 117.

SEC. 6. And be it further enacted, That the said trustees shall be, and they are hereby authorized and empowered by themselves, their deputies, agents, workmen, servants, and assigns, to commence, carry on, complete, and maintain such of the works and operations aforesaid, and such other works and operations as may be found expedient, for deepening the bed or channel of the river, upwards from the said harbour of Glasgow, to the south-east extremity of the public green of Glasgow, belonging to the corporation of the said city; and also to excavate and construct, out of and upon the bed or channel, or banks of the said river above, or to the east of the said bridge at the Broomielaw, and under the said bridge such a deepened navigable channel, cut, or canal, and tunnel, and below, or to the west of the said bridge, such canals, locks, tide-docks, and other similar works, as may be found requisite for opening and maintaining a communication, and safe and easy navigation for vessels loaded with coals or other commodities, passing from the higher parts of the said river to the said harbour at the Broomielaw, Sec. 7. Provided always, and be it further enacted, That the said trustees shall not, by any operations hereby authorized, injure or endanger any of the said bridges over the said river at Glasgow; and the said trustees shall be and they are hereby bound and obliged, from the rates and duties hereby granted for deepening the said river above the Broomielaw, to indemnify the magistrates and council of the said city, as trustees under the Acts for erecting and repairing the said bridges; and all others having a legal interest therein, against all or any damage or injury that may be sustained by the said bridges as aforesaid, and also to indemnify the Company of Proprietors of the Glasgow and Cranston Hill Water-works, and the Glasgow Gas-light Company, out of the said funds, for any costs or charges arising in the repairing any damages to be done to the water or gas-pipes of the said Companies carried along the said bridges: Provided also, That the whole of the said operations on, or in the vicinity of the said bridges, shall be performed at the sight, and to the satisfaction of two engineers, one to be named by the said trustees for the bridges, and the other by the said Company of Proprietors of the Glasgow Water-works, and in the event of their differing in opinion, by a third engineer, to be named by these engineers, who, in a report to be made in that behalf, shall state the works to be performed, and how they are to be performed, before the same shall be executed.

Sec. 8. Provided always, and be it enacted, That any lock to be constructed for the purpose of connecting the lower with the upper navigation, shall be placed below the new bridge, and below the weir now in the river, so that the level of the top of the gates of such lock shall not be higher than the present level of the top of such weir, and the masonry of the said lock shall not be higher than the surface of the ground under the south arch, and that the whole shall not present any greater hindrance or obstruction to the passage of the flood-water than is now presented by such weir.

Sec 9. Provided always, That the works hereby authorized to be carried on above the harbour of the Broomielaw, shall be conducted on such a plan, as neither to raise nor lower the surface of the River Clyde at low water above the new bridge of Glasgow: And provided further, That that part of the river which is situated between the wooden bridge, opposite to Saltmarket-street, and the south-east extremity of the green of Glasgow shall be deepened for the purposes of this Act, by scouring and dredging the channel thereof only.

Sec. 12. Provided always, and be it enacted, That none of the powers or authorities hereby granted, for, or in relation to the improvement of the navigation of the said river above the Broomielaw, shall be put in execution unless, and until the said trustees or others duly authorized shall, at the sight, and to the satisfaction of, and in conformity to a specification to be previously furnished by two engineers, one to be named by the said trustees, and the other, by the Company of Proprietors after mentioned; and in the event of the latter failing to do so within 30 days after a requisition upon them to that effect made then by the said trustees, have made and executed such works, as in the opinion of the said engineers (or, in case of their differing in opinion, of a third engineer to be appointed by these engineers,) shall be fully sufficient and effectual to preserve the bed or channel of the said river at Dalmarnock Bridge at its present height or level, nor until the sheriff depute of the county of Lanark shall be satisfied that sufficient means shall have been provided for the due preservation and repair in all time thereafter, of the works necessary for that purpose, so that no damage or injury from the execution of the said operations shall arise to the works of the Glasgow Water-works Company, incorporated by an Act passed in the reign of his late Majesty, intituled "An Act for supplying the city and suburbs of Glasgow with water."

Sec. 13. And be it further enacted, That in carrying into effect the provisions contained in this Act, in so far as regards the deepening of the said river above the harbour of Broomielaw, the rates and duties leviable for deepening that part of the said river above the said harbour shall be liable for any injury or damage which may be thereby occasioned to the said Water Company.

Extract from the Act 3 *and* 4 *Vict., cap.* 118.

Sec. 28. And be it enacted, That for the protection of the Company of Proprietors of the Glasgow Water-works, the said trustees shall be bound and obliged, and they are hereby required and authorized to support and maintain at its present height the dam or weir across the said river above the harbours of Broomielaw, and below Glasgow Bridge, until the said trustees shall have strengthened the weir, or the bed or channel of the said river at the old or Stockwell-street Bridge, in such manner as shall be sufficient to maintain the top water or head level of the said river at low water, at the height at which it is at present maintained above the said old or Stockwell-street Bridge, or until such other works shall be constructed below the water-works of the said Company of Proprietors as shall be sufficient to maintain the said top water or head level at the height at low water, at which it is at present maintained above the place where such other works may be constructed; which operations for strengthening the weir or bed, or channel of the river at the said old or Stockwell-street Bridge, or such other works as aforesaid shall be executed and maintained by the said trustees at the sight of two engineers, one of whom shall be nominated by the said trustees, and the other by the said Company of Proprietors; and the said two engineers shall have power, in case of any difference of opinion, to appoint a third engineer, to determine the point or points in dispute between them: Provided always, That nothing herein contained shall be held or constructed to interfere with or prejudice the rights of any parties which are now the subject of litigation in any suit or suits at present depending before any Court of Law, as such rights shall be ascertained and determined in such pending suits.

Sec. 29. Provided always, and be it enacted, That if any loss or damage shall arise to the said Company of Proprietors of the Glasgow Water-works by, through, or in consequence of the failure of the said trustees to fulfil the provisions herein contained for the protection of the said Company of Proprietors, or by, through, or in consequence of the insufficiency of the operations, or works to be executed by the said trustees for that purpose, or by, through, or in consequence of any operations executed under authority of this Act, then and as often as such loss or damage shall arise, the said trustees shall be bound and obliged, and they are hereby required and authorized to compensate the said Company of Proprietors for such loss or damage out of the funds and revenues of said trust: Provided always, That the said trustees shall not be liable for any loss or damage which may arise by, through, or in consequence of the exercise of any rights of any parties which are now the subject of litigation in any suit or suits at present depending in any Court of Law, as such rights shall be ascertained and determined in such suit or suits.

Sec. 30. And be it enacted, for the protection of Messrs. Henry Monteith and Company, and of Messrs. John Bartholomew and Company, as owners of certain dyeing and printing works situate on the banks of the said river of Clyde, at Barrowfield and Dalmarnock, and their successors in the said

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works, that if any loss or damage should arise to the said Henry Monteith and Company, or to the said John Bartholomew and Company, or theirs aforesaid by, through, or in consequence of the removal or lowering the said dam or weir above the harbour of Broomielaw, and below Glasgow Bridge, or the execution of any work or operation hereby authorized, or in case the said trustees shall not effectually prevent such loss or damage by the execution of works for that purpose, then and as often as any such loss or damage shall arise, the said trustees shall be bound and obliged, and they are hereby required and authorized to compensate the party or parties sustaining such loss or damage, for such loss or damage out of the funds and revenues of the said trust: Provided always, That the said trustees shall not be liable for any loss or damage which may arise by, through, or in consequence of the exercise of any rights of any parties which are now the subject of litigation in any suit or suits at present depending in any Court of Law, as such rights shall be ascertained and determined in such suit or suits.

No. 12.

No. 12.

Report on the Tay Navigation, from the Admiralty Surveyor on the East Coast of England to the Hydrographer to the Admiralty.

Her Majesty's Ship Blazer, Queen's Road,
Dundee, 1st October, 1844.

SIR,

Plan of the Tay.

HEREWITH I have the honour to forward a corrected plan of the river Tay, showing the changes that have taken place in the Gaa sand at the mouth of the river between the date of Captain Slater's survey in 1833, and our examinations just completed in September, 1844.

Taking advantage of the leisure time afforded while lying with the Royal Squadron in attendance upon Her Majesty, in the Queen's Road, at Dundee, and in accordance with your special instructions on this point, the banks at the mouth of this river have been thoroughly sounded over and examined; the results are all, I am happy to say, favourable, so much so that the shoal hitherto termed "Tay Bar" no longer exists, and vessels drawing 24 feet water may now enter the river, and bring up in safety within its shelter at the lowest water of spring tides.

Decrease of Gaa sand.

On comparing the two surveys, it appears that the spit of the Gaa sand, within the two fathoms' edge, which formerly extended from its extreme dry point off Buddon Ness, in about a S.S.E. direction, in a compact body, (1½ miles in length by ½ a mile in breadth,) has now turned outwards to nearly an E.S.E. direction; has moved bodily ½ a mile to the eastward, and is broken up into small patches, with deep water between, so that in spots where in 1833 were only 3 and 7 feet, we have found 16 and 20 feet water. One detached ridge of 12 feet water still remains to the southward of the spit, but from its extreme narrowness, being only half a cable wide, and its crescent-like form, I should imagine the first winter freshes, joined to a spring ebb, will disperse it like the rest.*

Slight increase of Abertay.

While these great changes (in which a mass of sand of not less than six millions of cubic yards has been removed) have been going on on the eastern side, the spit of the Abertay on the western side has grown out a little to the eastward (the natural consequence of being relieved from the pressure of the pent-up tide), but not at all so as to interfere with the entrance, which at the narrowest part is 800 yards wide between the 3 fathom edges. The general depth in mid-channel is also much increased, on an average about 10 feet, so that, as before stated, a vessel drawing 24 feet water, by bringing the Gaa buoy to bear W.N.W., may boldly run into shelter at the lowest spring tides.

Entrance well buoyed.

The edge of the Abertay sand is now well marked by three red buoys, to be left to 'Port' on entering, and the Gaa spit by two chequered black and white buoys, to be left to starboard, the passage lying between them, with the two Buddon Ness lights in one, which lead directly past the black Fairway buoy. By day, also, Lord Panmure's monument, recently erected on the summit of Camus Stone Law, kept a little open to the eastward of the remarkable red Gaa sand-hill, will lead up to the entrance.

Within, the channel of the river does not seem to have much altered, if anything it is deeper; a black buoy has been lately placed on the Horse-shoe shoal, near Broughty Castle; and the Newcome spit, just off the Craig Lights, still projects from the south shore, nearly half across the river.

Drummond Rock.

Off the town of Dundee we found a rock, named Drummond Rock, not placed in any plan of the river, with only 4 feet on it, marked by a floating beacon; and close in to the westward are rocks called the Gryces, also marked by a floating black spar. The position of the Drummond Rock, just at the entrance of the basin, is so dangerous, that if it be allowed to remain, which I can hardly imagine, it should be marked by a fixed beacon, like the "Fowler" and "Beacon" rocks, in its immediate vicinity. A little to the westward of the town, the "Ballast Bank," lying between Magdalen-yard Point and the Craig rock, has turned out a little, and come lower down the river—a point that requires great attention; the 'Middle bank,' however, has not increased.

Queen's Road.

The roadstead in which the Queen's yacht and the royal squadron are anchored lies between these two banks, in 20 feet at low-water springs. It is perfectly sheltered and secure, and the bottom affords good holding ground. As this roadstead has no name on the Admiralty plan of the river, we have ventured to call it Queen's Road, in remembrance of Her Majesty's auspicious visit to this part of Scotland.

Improvement in Dundee.

The alterations and improvements in the sea-face of the town of Dundee, since the date of Captain Slater's survey in 1833 are great; but compared with its state within the memory of man, "when its harbour was a crooked wall, enclosing but a few fishing or smuggling craft," they almost exceed belief. Two spacious wet-docks, containing an area of 11½ acres, are already completed, and in full activity; another wet-dock, of more than double the extent, is laid out; with two tidal harbours, one of 5 acres, now in use, the other of 11 acres: besides graving docks, patent slips, and every requisite for a first-class commercial port. The good result of such enterprize and energy, directed by a skilful engineer, is shown by the more than doubled revenue of the port, and the increase in the number of the shipping that frequent it:—

	£.
In June, 1833, the total revenue was . . .	10,291
In June, 1844, ,, . . .	23,895

While the number of shipping had increased to 3791, having a burthen of 272,239 tons.

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* The only other plans of the river which I have seen are one by the Messrs. Stevenson, engineers, made in 1816, and that of Greenvile Collins, (who by direction of Charles II., surveyed these coasts in 1686,) published in his "Coasting Pilot." The plan purporting to be by Adair, said to have been published in 1690, is a fac-simile of that of Greenvile Collins.

Rocks should be blasted away.

Hitherto all has been prosperous, and probably will be so for years to come; but it is not difficult to foresee that, unless some decisive steps are taken to prevent it, the face of the quays and the entrance to the tidal basins will silt up. Already a dredging-machine is in constant employment. The Fowler, Beacon, and Drummond rocks, just to the eastward of the entrance, in addition to the impediment they offer to navigation by causing a slack on the flood tide, are occasioning a deposit, and a slight concavity in the face of the sea-wall tends to lead the silt into the basin; at the same time the Ballast Bank is gradually extending to the eastward, and widening. The most obvious mode of arresting these evils would seem to be by blasting the rocks entirely away, and by running a sea-wall from Magdalen-yard Point, in a slightly curving direction, to the Craig Rock, in order to guide the ebb stream in its strength along the face of the quay. This plan has, I believe, been proposed by Mr. James Leslie, the very able resident engineer; and although there may be some conflicting interests to contend with, everything should give way to the careful preservation of the port, and I trust he may be allowed to carry out his plans.

Embankments.

Continuing higher up the river, as far as Newburgh, the only perceptible changes that have taken place are, I regret to say, caused by embankments and dykes along the north shore. One of these extends into the river upwards of 1000 yards beyond high water mark; and were a curved line drawn, connecting the outer ends of these dykes, and continued as far as Monorgan Point, which would be the natural shape of the deposit caused by them, it would enclose a space of nearly 2000 acres, or 3 square miles. Now, when it is considered that the whole estuary between Dundee and the mouth of the Earn does not reach 18,000 acres, or 28 square miles, (16 of which are dry at low water,) it will be manifest that the space embanked is equal to nearly one-ninth part of whole estuary; and as the outer ends of some of these dykes have from 10 to 12 feet over them at high tides, it is evident that a large body of tidal water will eventually be excluded, and its scouring power lost, which must have a decided influence upon the banks in the lower part of the river, and opposite the town of Dundee. This is a great evil, and should be jealousy watched, as it is the scouring power of the tidal waters ebbing and flowing twice in the 24 hours that is the great agent in preserving our harbours from silting up.

Area of Estuary.

River Improvements.

From Newburgh upwards, towards Perth, the changes in the river since the date of Captain Slater's survey have been great and beneficial. Between the years 1835 and 1842 the principal fords, some shoals, and many detached boulder-stones of large size have been removed, and the river along its whole course, between Perth and Newburgh, has been deepened. Three small islands, namely Sleepless, Darry, and Balhepburn, have been connected with the main land by sea-walls, so as to confine the whole of the water in the navigable channel, and render the scour more effective. The banks of the river, where contracted, have been widened so as to admit of the free and equal passage of the water, and a tide harbour has been formed at Perth. In the course of these works not less than 840,000 tons of soil have been dredged up, and the sum of 53,000*l.* has been laid out in improvements, independently of indemnification to the proprietors of the fisheries to the extent of 6000*l.* The advantages arising from these energetic works, carried on under the direction of the well-known skilful engineers, Messrs. Stevenson, of Edinburgh, have been many; by affording a free passage to the tidal waters, the flood tide now begins to flow at Perth three-quarters of an hour earlier, and has a range of 13 feet at the bridge at ordinary springs; a depth of from 4 to 5 feet is said to be maintained in the channels at low water springs, and the general navigation so improved, that at spring-tides vessels drawing 14 feet water can come up to Perth in one tide with ease and safety.

Increased trade.

The natural consequence of this has been, that the number of vessels that resort to this port has much increased; the arrivals and sailings in the past year, amounting to 944, of 45,325 tons' burthen, in addition to daily steamers between Dundee, Newburgh, and Perth; the harbour and customs dues have increased in equal proportions, the latter from about 3000*l.*, in 1830, have risen to an average of 16,837*l.* per annum, while in one year they were as high as 25,767*l.*

Basin of the Tay.

So far good; but the Tay is susceptible of much further improvement. This magnificent river drains a surface of about 2300 square miles, or nearly double that of any river in Scotland; its length from the source of its most distant tributary is near 180 miles, while the variety in the relative distances of its sources furnishes an abundant and equable supply of water without the great floods that the Spey and Dee, and other mountain rivers, are so subject to. These are capabilities that a skilful engineer would readily turn to account; and I sincerely trust the Perth Trustees will go on with the work they have so well begun. Little else is wanting than to remove all obstructions in the bed of the river, and carefully to narrow the channel within certain limits in its upper part, gradually widening as it descends, at the same time dredging and deepening, so as not only to preserve the present, but to increase the sectional area of the channel, thereby affording full and free space for the tidal waters to ascend up to the bridge at Perth, and as much beyond as the natural obstructions in the bed of the river will permit.

Value of tidal waters.

The value of such free action to the tidal waters is not confined alone to the upper channel, but improves the river throughout. In the former part of this Report I pointed out the great change in the Gaa sand at the mouth of the river, and that six millions of cubic yards of sand had been dispersed since the year 1833, the date of the last survey.

Now, from every inquiry I have made I do not find that any remarkable freshes in the river have occurred during the last 11 years; but we know that a deepening of the bed of the river in its upper part has been gradually going on since the year 1835, by which a depth of 4 feet has been gained in several places, and the tidal water brought up to Perth three-quarters of an hour earlier. In the course of this dredging we have seen that upwards of 800,000 tons of soil have been removed, and although it is not easy to make an estimate of the consequent increase of reservoir, it is fair to assume that at least an equal number of tons of water (or say in round numbers a million of cubic yards) have been admitted on every tide.

And when we consider the additional scouring power gained by this increased volume of water passing to and fro twice a day, or 704 times in a year, it seems a fair inference, in the absence of any other known cause, that this has been the chief instrument in the improvement in question.

If, then, we may assume that the dredging which has already taken place between Perth and Newburgh has proved so beneficial to the Tay Bar at a distance of 25 miles, who can say that skilful engineering along its whole length might not eventually raise this river to the high rank of a Harbour of Refuge, and render the channel into the Frith of Tay as free as the present entrance into the Frith of Forth.

I am, &c.

JOHN WASHINGTON, *Captain.*

P.S.—I have great pleasure in bearing testimony to the ready attention and assistance I have met with from Mr. James Leslie, Resident Engineer, Lieut. Smart, R.N., Harbour Master, and Mr. Kennedy, Master of the Pilots, throughout our survey and inquiries.

APPENDIX.

No. 13.

No. 13.

Reports by the Engineer of the Dundee Harbour, regarding the Operations of Lord Kinnaird and Colonel Paterson, on the bed of the River Tay; referred to in the Report of James Walker, Esquire.

GENTLEMEN, *Dundee, 22nd September*, 1843.

I FEEL it my duty to call your attention to the fact, that a long dyke is now being built on the north shore of the river Tay, opposite the march between the properties of Lord Kinnaird and of Colonel Paterson of Castle Huntly.

This dyke extends outwards from high-water line, across the north banks of the river, with a view, I presume, to promote the silting up of the shore, and thereby to allow, in time, of a portion of ground being embanked from the tide and rendered arable, in the way that has been done by other proprietors on the north side of the river between that place and the mouth of the Earn.

I do not know what is to be the length of the dyke, as the advertisement for tenders, of which a copy is annexed, is expressed in very general terms; but I have reason to believe that it was at one time contemplated to extend it above two-thirds of a mile out from high-water mark, and that even more than double that length had been spoken of, which would have carried it considerably more than half way across the river.

Any encroachment on a tidal river or estuary, by lessening the quantity of its back-water, must diminish the strength of the scour at the lower parts of the river, and must thereby tend to form banks there, and so to injure the navigation; and, therefore, it is of the utmost importance to the interests of the Harbour of Dundee, that the estuary of the Tay should not be encroached on, or its capacity diminished by forming embankments, or by using any other artificial means to promote the silting up of its shores. It may be a question, whether any of the embankments, or other works, that have been already executed, or are now in progress, be of sufficient magnitude or importance to render any interference with them expedient or advisable; but it does seem indispensable that some inquiry should be instituted; for it is very evident that one encroachment leads to others, and that, if they were allowed to go on, without being objected to, they would soon increase to such an extent as to be attended with very injurious consequences.

The magistrates of Perth, or the Navigation Commissioners, if they do not encourage, seem at all events to take no means to prevent encroachment on the *north* shore—their object being, it would appear, to confine the navigable channel, as much as possible, to the *south* shore; and with that view they lately brought an action, and got a verdict of a jury, for the removal of several dykes or jetties on the property of the Earl of Zetland, between Flisk and Newburgh.

Now, the narrowing of the river may be of advantage to the navigation between Perth and Dundee, and more especially between Perth and Newburgh, but it is decidedly injurious to the navigation at and below Dundee; and the long dykes extending outwards from the north shore are especially hurtful to Dundee, by throwing the strength of the current over to the south side of the river, to which there is already too great a tendency without its being increased by artificial means.

I have the honour to be,
Gentlemen,
Your most obedient servant,
JAMES LESLIE.

To the Trustees of the Harbour of Dundee.

(*Advertisement referred to.*)

CONTRACTORS WANTED.

To build a sea wall at Polgavie; apply to James M'Laren, at Castlehill, betwixt this and the 24th current.

Castlehill, May 10th, 1843.

(From *Advertiser* of 12th and 19th May.)

GENTLEMEN, *Dundee, 16th October*, 1843.

AGREEABLY to the instructions given in your minute of the 4th instant, I last week, accompanied by Mr. Milne, visited and examined the dyke now being built on the north shore of the Tay, opposite the march between the properties of Lord Kinnaird and Colonel Paterson of Castle Huntly.

I measured and took the bearings of the dyke, and have laid it down on the accompanying plan.

The foundation is laid to the extent of 3110 feet, or four-sevenths of a mile, out from high-water mark, and in a direction bearing S. by E., by compass. The building is completed to the length of 410 feet; at which distance the top, which is about level with high water of spring-tides, is 8½ feet above the surface of the mud. A farther length of 917 feet is raised to about half its height, or from 4 to 6 feet; and the remaining portion, which is founded, is about a foot or 18 inches in height above the surface of the mud.

I have no information as to whether it be intended to carry out the building beyond the length already founded. There are no stones laid down beyond that distance to indicate any immediate intention of proceeding farther; but the stones at the end are not laid as if they were to form a permanent finish to the building. The length founded is exactly two-ninths of the whole width of the river. The surface of the mud-bank at the outer end is from 10 to 12 feet below the level of high-water of spring-tides; and the outer end of the dyke will, accordingly, if carried up to the same level as the inner end, be 10 or 12 feet in height. Considerable works were executed several years ago by Lord Kinnaird with the view of gaining land to the westward of the march dyke herein spoken of, and extending along the shore about a mile and a third, to Powgavie, where there is a small shipping harbour. These consisted chiefly of wickerwork fences, both at right angles and parallel with the shore, so as to intersect each other, and one running obliquely along the east side of the Pow. The plan shews the state of these two years ago; but considerable additions have been made, both to their number and their lengths since that time; and just now, in some places substantial stone dykes are being substituted for the wickerwork;—in particular, for that fence which runs out at right angles with the shore to join the one running obliquely along the side of the Pow, and which, at the junction, extends about as far out from the land as the present end of the foundation of the March Dyke.

The area that would be enclosed between the March Dyke on the east, and the fence along the east side of the Pow on the west, supposing them not to be extended beyond their present lengths, would be 340 acres; but the effect in causing a silting up would be very great, both above and below these works, as well as upon the shore opposite the property of Lord Kinnaird.

The plan shows also the long dykes that have been at various times built on the estates of Seaside and of Errol.

I have the honour to be, Gentlemen,
Your most obedient servant,
JAMES LESLIE.

Further Statement prepared for the purpose of being submitted to Counsel.

From the bar or mouth of the river Tay to Dundee, a distance of 11 miles, the width at low-water varies from three quarters of a mile to about a mile and three quarters; and the narrowest place, viz., at Broughty Ferry, is nearly a mile in width at high-water.

Between Dundee and the confluence of the Tay and the Earn, a distence of 15 miles, the width of the estuary at high-water varies from three miles at Invergowrie Bay to one mile and a seventh at Newburgh, and to five-eighths of a mile above Mugdrum Island, immediately below the mouth of the Earn; and the area is about 17,800 acres, or $27\frac{3}{4}$ square miles. Of this area, about four-sevenths is dry at low-water of spring-tides, the remaining three-sevenths being under the level of low-water, or occupied by the fresh-water channel of the river.

The waters of the Tay and the Earn bring down with them a great quantity of alluvial matter, more especially during freshes; and there is, consequently, a very great tendency to deposit the matter held in suspension, wherever the velocity of the current is diminished by the river widening out into an estuary, and by its meeting the tidal waters of the ocean.

The sand and other heavy matter is frequently deposited in large quantities, even in mid-channel, wherever there is an eddy, or where the current has not sufficient strength to sweep it along; while the mud and other lighter particles can only settle down to the bottom in those places where there is neither much current nor wave; or, if it do settle down in an exposed situation during quiet weather, it is liable to be washed up again by the first jabble of a sea that breaks over it; but in perfectly sheltered situations, where there is no current, the deposit is extremely rapid.

The navigation at and below Dundee is kept open solely by the rush of the tidal waters into and out of the estuary being sufficiently strong to sweep away the sand brought down by the river; for the mere fresh water of the river alone would never suffice to keep down the bar, and otherwise to maintain the depth necessary for the lower navigation.

The channel of the united rivers above Mugdrum does not exceed 700 feet in width at low-water, or one sixth of the width at the strait of Broughty Ferry; and except during freshes, neither the depth nor the velocity is very great.

It is evident, therefore, that the body of water which finds an easy passage through this confined channel, would be of itself quite insufficient to serve as a scour to the mouth of the river; and that it is, consequently, of the utmost importance to maintain the full strength of the tidal current; and for that purpose to preserve entire the size and capacity of the estuary, and not to allow it to be encroached upon by artificial means.

Not many years ago, the Tay, after being joined by the Earn, used to run so strongly along the north shore, as to undermine and endanger the land; and a wall was required to be built along the foot of the water braes for their protection.

A late proprietor of the estate of Errol, seeing the difficulty and expense of keeping up these parallel dykes, altered the system to that of projecting dykes at right angles out from the shore; and these soon caused such a deposit of mud or sleek in the eddies produced by them, that a large space of land has been gained from the shore where there was formerly deep water; and the parallel dykes, which were formerly so indispensable, have been lifted to form embankments a long way farther out.

These cross dykes have been extended farther of late years, and one of them is now 1800 feet long.

This plan being found so efficacious both for the protection and the acquisition of land, has been adopted by many of the neighbouring proprietors, viz., by Sir John Richardson of Pitfour, Lord Kinnaird, and Mr. Hunter of Seaside, on the north shore; by Mr. Hay of Mugdrum on the north side of Mugdrum Island; and by Mr. Paterson of Carpow, and the predecesssors of the Earl of Zetland, on the south shore.

The magistrates of Perth, or the River Commissioners, have taken no steps to prevent encroachments on the north shore, or on the north side of Mugdrum Island, but rather seem to have encouraged them. They, however, lately brought an action against Lord Zetland to compel the removal of the dykes on his estate of Balmbriech, below Newburgh, on the ground that they formed sand-banke and impeded the navigation; although some of them had stood for about 40 years, and the longest of them was not one-fourth part of the length of some of those on the north shore; and, although, in consequence of the increased strength of the current along the south shore, caused by the partial shutting up of the channel north of Mugdrum, the land on the south shore was washing away, and stood much in need of protection.

The case came to a jury trial; and ultimately Lord Zetland's legal advisers gave up their case without making any defence; and the whole of the dykes upon the estate libelled, which included all that were of any value, required to be pulled down and removed.

It appears, therefore, that it is the object of the Perth authorities to narrow the river, and to confine it as much as possible to the south shore; and that, consequently, the trustees of Dundee Harbour need not trust to them for attending to the interests of the lower navigation.

It is, indeed, evident that there can be no community of interests in the matter. The navigation between Dundee and Perth, but more especially between Newburgh and Perth, is very shallow, and only available for a very small class of vessels.

It would be an object to get a few feet more depth of water; but the very most that can be got there must be much less than the depth at and below Dundee, even supposing that were diminished considerably within what it is at present. It is, therefore, for the interest of the people of Perth to narrow the estuary as nearly as possible to the width required for the passage of the river water, so that the channel might thereby be scoured proportionally deep; and the ulterior effects on the lower navigation are to them of comparatively little importance.

As regards Dundee, however, the case is very different. The trade of Dundee is carried on chiefly in large vessels, and a sum of 400,000*l.* has been expended in the construction of harbours and docks with sufficient depth for the accommodation of these vessels, which would in a great measure be lost if the lower navigation were allowed to be interrupted by shoals and sand banks; and shoals would inevitably arise there if the influx and reflux of the tide were stopped or materially lessened by the silting up of the estuary.

The trustees of the harbour of Dundee having, therefore, decidedly a beneficial interest in the tidal scour at and below Dundee, are undoubtedly entitled to interfere for the purpose of preventing the strength of the scour being lessened, and for that end to resist any encroachment on the estuary of the Tay, more especially those projections from the north shore which have a tendency to throw the strength of the current over to the south shore, and thereby to cause slack water in front of the harbour.

The property of Lord Kinnaird is situated on the north shore of the Tay, from 6 to 7½ miles above Dundee. The estuary is 2¾ miles wide at high-water opposite the east boundary, and 2 miles opposite the west boundary of the estate; and the mud-bank out to low-water is fully a mile and a half broad. Several years ago a number of wicker-work fences were constructed by Lord Kinnaird, extending across the bank, chiefly at right angles with the shore, but some also parallel with the shore, and intersecting the former; and one running obliquely along the east side of the Pow, a stream which runs into the river between his Lordship's property and that of Mr. Hunter, of Seaside, at the small shipping harbour of Powgavie. The Pow, instead of running directly across the bank, slants along shore to the eastward, so much that at the distance of four-fifths of a mile from Lord Kinnaird's west march, it is only three-fifths of a mile out from the land. The object of these works seems to have been to prevent the Pow from pushing its channel more to the eastward; but they were no doubt also undertaken with the view of acquiring land, and accordingly a great silting has taken place in consequence of them.

The work, now more immediately referred to, is a dyke which was commenced about the month of May last, upon the shore opposite the march between the properties of Lord Kinnaird and Colonel Paterson, of Castle Huntly.

The foundation of it is laid to the extent of 3110 feet, or four-sevenths of a mile out from high water mark and nearly at right angles with the shore; and a length of 410 feet of it is finished, and on a level with high water of spring tides. It is not known whether it be the present intention to carry out the building farther than the foundation is laid; but undoubtedly it was at one time in contemplation to extend it farther; and the outer end of the foundation does not show anything like a permanent finish. The length founded is exactly two-ninths of the whole high-water width of the river at that place, and the surface where the outer end stands is covered to the depth of 10 or 12 feet at high water of spring-tides.

Lord Kinnaird has been lately extending and increasing the number of the wicker work fences, and rendering them more permanent by packing them with stones, and for some of them he is now substituting substantial stone dykes; amongst others, for a fence of 2780 feet long, which extends directly out from high-water to join the oblique fence along the east side of the Pow.

The area that would be inclosed by joining the outer ends of the fence last mentioned, and of the new march dyke between the properties of Lord Kinnaird and Colonel Paterson, would be 340 acres; but the effect that would be produced by these works in causing a silting, both above and below, as well as upon the property of Lord Kinnaird, would also be very great.

Supposing a line to be drawn to connect the extreme ends of all the dykes, or other projections as they now stand or are founded on the north shore, and on the north side of Mugdrum Island as far up as the confluence of the Tay and the Earn; and supposing the space affected by the lowermost dyke, viz., that between Lord Kinnaird's property and Castle Huntly, to tail off to Monorgon point, the nearest headland on the east, at the distance of about a mile; the area that would be included within the line just described would be 1920 acres, or three square miles, which is equal to about one-ninth part of the whole estuary of the Tay between Dundee and the mouth of the Earn.

The area of 1920 acres here mentioned includes about 70 acres embanked within these seven years, and rendered arable opposite the estate of Errol, besides considerable spaces silted up between the dykes, and covered with reeds and salt grass on the north side of Mugdrum and elsewhere, but is exclusive of a great extent of ground embanked by Sir John Richardson opposite the mouth of the Earn, as I have no proper data for the measurement of that space of ground.

It is impossible to calculate, without having sections of the shores, what is the quantity of water that has been or would be excluded by these embankments and other works, as it does not increase in the same ratio as the area embanked or silted up, but depends as much upon the levels of the ground. It is evident, however, that since some of these works stand on ground which is covered to the depth of 10 or 12 feet at high-water, the quantity of water that would eventually be excluded by them would be so great as to have a decided influence on the strength of the scour at the lower parts of the river.

The accompanying plan shows the state of all the works herein described in summer 1841, and also the new dyke now building by Lord Kinnaird and Colonel Paterson, so far as it is founded; but it does not show the other dykes and fences constructed within these two years by Lord Kinnaird.

If the works before described be allowed to proceed and to remain without challenge, there is little doubt that similar works will be attempted on the north shore, still farther down; where, besides their injurious tendency, in common with the others, in diminishing the size of the estuary, their direct action will, from their vicinity to Dundee, be more immediately felt, in throwing the current still more strongly over to the south shore, to which it has too great a tendency already, and thereby in lessening the strength of the tide along the outside of the harbour.

Dundee, 24th October, 1843. JAMES LESLIE.

Abstract of the foregoing Statement.

Mouth of the River Tay to Dundee, 11 miles.
Widths at low water, $1\frac{3}{4}$ to $\frac{3}{4}$ mile.
Ditto at Broughty Ferry at high water, nearly a mile.
Dundee to Earn mouth, 15 miles.

Widths at high-water—3 miles at Invergowrie Bay; $2\frac{3}{4}$ miles at the east boundary, and 2 miles at the west boundary of Lord Kinnaird's estate; $1\frac{1}{2}$ miles at Newburgh; $\frac{5}{8}$ mile above Mogdrum.

Width at low-water at the narrowest, viz., below the mouth of the Earn, 700 feet—$\frac{1}{8}$ mile.

Area of estuary from Dundee to Earn mouth, 17,800 acres, or $27\frac{3}{4}$ square miles, whereof $\frac{4}{7}$ dry at low water.

Lord Kinnaird's estate above Dundee, 6 to $7\frac{1}{2}$ miles.

Length of new dyke between Lord Kinnaird and Colonel Paterson, 3110 feet.

Length of Lord Kinnaird's longest wicker-work fence, 2780 feet.

Area between the fence, along the side of the Pow, and the new dyke, 340 acres.

Longest dyke, opposite Errol estate, 1800 feet.

Area that would be included within a line drawn to connect the outer ends of all the jetties and Monorgan Point, 1920 acres, or 3 square miles—equal to one-ninth of the whole estuary between the mouth of the Earn and Dundee.

J. L.

No. 14.

No. 14.

Copy Letter—Adam Burnes, Writer, Montrose, to Sir James Carnegie, of South Esk, Bart., Kinnaird Castle.

"SIR, "Montrose, 20th December, 1842.

"I HAVE the honour, by directions of the Trustees of the Harbour of Montrose, to address you on the subject of the recent embankments made by you, or under your authority, in the basin or estuary of Montrose; whereby, according to the report of Mr. Rendel, founded on personal inspection and on the joint statement of the engineers, employed by you and the Harbour Trustees, it appears that upwards of 62 acres of ground have been taken possession of by you, to the injury and prejudice of the harbour of Montrose.

"I am directed by the trustees to intimate to you, that the Lords Commissioners of the Admiralty have been pleased to signify their approbation of the course recommended by Mr. Rendel, viz., that you should be permitted to complete the embankments in question, on the condition that you undertake the widening and deepening of the new channel of the South Esk River, and the whole other works described by the plan, sections, and specifications, which accompany Mr. Rendel's report; the whole, works referred to, to be commenced on or before the 1st day of April next, and to be completed at your expense on or before the 30th day of November same year, in every respect conformably to the said specifications and relative plan and sections, copies of which, as well as of Mr. Rendel's report, are already in your possession. I am therefore directed to request, that you will have the goodness to intimate to me in writing, within 14 days from this date, what course you mean to pursue in regard to the embankments in question, and, in particular, whether you intend to remove these embankments, or to adopt the alternative recommended by Mr. Rendel, of which the Lords of the Admiralty have signified their approbation; as you will observe from the accompanying copies of two letters, dated 9th and 14th instant, addressed to me by Sir John Barrow, one of the joint Secretaries to the Admiralty. I have also to intimate, that the present communication is made on the understanding that the expenses of the surveys and reports, and of any superintendence of works, and of the legal proceedings hitherto had, shall be defrayed by you.

"I am directed to assure you, that the Trustees of the Harbour of Montrose have no wish to interfere unnecessarily with the rights of yourself, or of any other proprietor, whose lands adjoin the Montrose Estuary, but as the local guardians of the Montrose Harbour (of which, as of other harbours in the kingdom, the Lords of the Admiralty are the public conservators), they feel it to be their duty to resist any encroachments or enclosure of ground on that estuary, not only as being illegal operations, but as calculated, in the opinions of the most eminent engineers, seriously to injure a harbour, which depends mainly, if not solely for its efficiency on the scour or the discharge of back water from the estuary to the sea.

"As certain legal proceedings are in dependance in the Court of Session relating to the encroachments in question, I am under the necessity of intimating that the present communication shall not be held to prejudice or affect these legal proceedings, nor the rights competent to the Lords of the Admiralty or to the Harbour Trustees to enforce the removal of the embankments in question, should the course recommended by Mr. Rendel not be followed out.

"I have the honour to be, &c.

(Signed) "ADAM BURNES."

"*Sir James Carnegie, of South Esk, Bart.,*
&c. &c. &c.

No. 15.

No. 15.

Mr. J. M. Rendel's Report on Montrose Harbour, 1842.

SIR, 34, *Great George Street, Westminster, 24th November*, 1842.

YOUR letter of the 18th July last, accompanied by sundry Plans and Reports, on the subject of an inclosure of tidal mudlands on the shores of the Montrose estuary, by Sir James Carnegie, of South Esk, baronet, with instructions to me to report thereon, as suggested by the Lords Commissioners of the Admiralty in the Hon. Sidney Herbert's letter of the 15th July, in reply to your letter and memorial of the 6th, reached me at Dundee on the 20th July; and on the 23d I proceeded to Montrose, and in company with Mr. Leslie, the engineer to the Harbour Trustees, and Mr. Blackadder, the engineer appointed by Sir James Carnegie, to execute the embankments complained of, I made a close inspection of the works both at low and high water, and of the shores and channels of the harbour from thence to the sea.

Finding that Mr. Leslie and Mr. Blackadder differed in opinion on points which I deemed important to the inquiry, an actual survey, including a measurement of the ground embanked, and a

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series of tidal observations jointly executed by those gentlemen, became a necessary preliminary to any farther proceedings. On the 26th September last, I received the results of their survey, properly authenticated, which, with all other papers submitted to me, I have well considered, and now I beg to submit the following Report.

The estuary in which the works under consideration have been made, is of that class which the sea has formed by throwing up banks of sand across the mouth of a deeply recessed bay, converting the space within into a kind of tidal basin, or salt-water lake. The channel which connects it with the sea constitutes the harbour of Montrose, which is kept deep and commodious by the great quantity of water running through it between the sea and the basin, during the flux and reflux of every tide.

This brief but general description will suffice to show that a mutual dependence subsists between the harbour and the estuary. For instance, supposing the harbour to be contracted by injudicious works, so as to prevent a full flow of tide into the estuary, its shores and elevated parts being no longer flowed over, would be covered with vegetation, and rapidly become productive land; and supposing the estuary encroached on in a manner to reduce the quantity of water passing through the harbour, its depth and capacity would, as a consequence, be correspondingly diminished.

Now, it appears from the joint survey of Mr. Leslie and Mr. Blackadder, that the embankments making by Sir James Carnegie, have reduced the area of the estuary upwards of 62 acres, and the quantity of tidal water flowing into it at spring tides, upwards of 10½ millions of cubic feet, and at neap tides nearly 3 millions of cubic feet. It follows, therefore, as a consequence, deducible from the preceding description of the harbour, that this great loss of backwater will be the cause of injury, and that the interference of the harbour trustees was a proper and necessary measure.

The restoration of the land embanked is perhaps the only remedy that can be legally insisted on. I am not, however, prepared to recommend it as the best. I would suggest, as a preferable course, that Sir James Carnegie should be permitted to complete his embankments, provided he will undertake the widening and deepening of the new channel of the South Esk river, to the extent described by the plan, sections, and specification, which accompany this Report.

The adoption of this compromise, though leaving a loss of backwater at spring tides of upwards of 7 millions of cubic feet, will give an increase of 2½ millions cubic feet at neap tides; whilst from the excavations it imposes being at a level considerably below the greater portion of the embanked mudlands, the water gained will be more beneficial to the scour of the harbour and estuary, than an equal quantity of that which has been taken away.

That it will be the interest of Sir James Carnegie to adopt this compromise is sufficiently manifest, and I would strongly recommend it to the preference of the harbour trustees, under the circumstance of their having sanctioned the diversion of the South Esk river, which, in the course of years, would infallibly have led to the silting up of its old channel, and the adjoining mudlands, which comprise the whole space now embanked.

In conclusion, I feel it my duty to echo the recommendation given by Mr. Walker to the harbour trustees, in his Report of the 18th January, 1839, that they should watch with jealousy any attempt at encroachments of the shores of this estuary; and as the most effectual means of rendering such watchfulness operative, I would recommend that it should be an instruction to their harbour master to make the circuit of its shores at least monthly, and present a written report on the result.

And farther, that as a means of knowing with exactitude any changes occurring within it from natural causes, levels should be taken on numerous lines between well defined and permanent marks on the opposite shores, from which sections should be laid down and preserved as official documents, so that by a repetition and comparison, every three or four years' changes in its bed and channel, however minute, might be noted and registered.

These are precautions which the importance of the harbour fully justifies, and which its nature requires.

I am, Sir,
Your most obedient Servant,
(Signed) JAMES M. RENDEL.

To Adam Burnes, Esq., Clerk to the Harbour Trustees.

Specification of Works to be done in widening and deepening the Channel of the River South Esk, between the Bridge of Dun and Old Montrose.

1st. The present channel of the river is to be widened, and otherwise formed, to correspond in dimensions and shape with the plans and sections attached hereto.

2nd. The whole of the soil required to be removed in executing the works described, is to be taken to such parts of the low ground within the new embankment made by Sir James Carnegie, Bart., as his engineer, or agent, may from time to time direct. Or if such engineer, or agent, shall deem the excavated soil unsuitable for levelling the embanked land, then the contractor must remove it to such place as the engineer appointed by the Montrose Harbour Trustees may approve, the deposit being made beyond the reach of the highest known tides, and in such manner that no portion of the excavated soil shall be liable to fall, or be thrown into the estuary.

3rd. That both slopes of the new channel, from the bridge of Dun to the letters Y Z on the plan, are to be coated or protected with whinstone, in the same way, and to the like extent and thickness as the north-west end of the new embankment, where it crosses the old channel of the river.

4th. In case any of the soil required to be excavated in the execution of these works, shall, either from accident or neglect, be washed away by the river, a quantity of soil equal thereto shall be removed from some other part of the estuary, as may be decided on and pointed out by the engineer of the harbour trustees, and the place of deposit for the soil so to be removed shall also be determined by the said engineer, but as near to the place where the excavations are required to be made, as a compliance with the restrictions already specified as regulating the deposit of soil will admit of, and

5th. The works are to be commenced on or before the 1st day of April, 1843, and must be completed on or before the 30th day of September of the same year, under the joint superintendence of the engineer to the harbour trustees, and the engineer to Sir James Carnegie; and in the event of any difference or dispute arising between them as to the meaning or intention of any part of the plans, sections, or these specifications, the same shall be referred to an engineer to be named by the Lords

Commissioners of the Admiralty, and his decision to be final and binding on Sir James Carnegie and the harbour trustees.

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(Signed) JAMES M. RENDEL.
34, *Great George Street, Westminster,*
24th November, 1842.

A true Copy,
ADAM BURNES,
Clerk to Trustees of Harbour of Montrose.

No. 15 *a*.

No. 15 *a*.

Memorial for the Trustees of the Harbour of Aberbrothwick, in the County of Forfar.

The Memorialists have, by persevering exertion, and at considerable expense, succeeded in enlarging and greatly improving the Harbour of Aberbrothwick, but they find themselves, from the want of funds, altogether unable to accomplish important parts of their plan. There are still works to complete, particularly the deepening of the harbour and its entrance and approaches, without which the great public benefits which the improvement of the harbour is calculated to confer will be in some measure lost. The position of this harbour is such, as shall be afterwards adverted to, that independently of its importance to a large and populous district, it could easily be made a harbour of refuge, where a harbour of this description is most wanted, and might thus become a national object; and considering the efforts made by the parties locally interested, and what they have accomplished, the Memorialists venture to entertain the belief that there is a well founded claim on the Government for encouragement and assistance in their present difficulties.

The Memorialists were incorporated under the Act 2 Vict., cap. 16. At that time the Harbour of Aberbrothwick belonged to the Magistrates and Town Council of the Burgh. "The piers, quays, and other works of and within the harbour had become insufficient for the accommodation of the shipping and trade of the burgh, and they were unfit for the reception of vessels of any considerable size." Application was, therefore, made to Parliament, and the Act referred to was passed, appointing trustees, with power to acquire the right to the harbour from the Magistrates and Council, to take the administration of the harbour, and to carry out the plan for its extension and improvement. For these purposes the trustees were authorized to borrow and take up at interest, not exceeding the sum of 50,000*l.*, on the credit of the harbour, and rates, and duties, and other revenue and property of the same.

The Memorialists have, to the utmost of their power, carried into effect the objects of the Act. They have repaired and greatly improved and enlarged the harbour, having constructed a sea wall, and a new outer harbour, and other works, whereby the accommodation for the shipping and trade of the port has been much more than doubled.

In carrying on these works, the Memorialists have already expended a larger sum than the whole funds provided are adequate to pay. As before stated, the sums authorized to be borrowed under the Act of Parliament are limited to 50,000*l.* Up to this time the Memorialists have expended on the works contracted for and executed by them (including 10,000*l.* paid to the Magistrates and Town Council for the Old Harbour) not less than from 57,000*l.* to 58,000*l.* A part of this outlay, to the extent of from 4000*l.* to 5000*l.* has been liquidated by means of the surplus revenue for the last few years. But the mortgage debt amounts to 50,000*l.*, and there is besides upwards of 3000*l.* due to the contractors and others, for the payment of which no funds are yet provided. The Memorialists have been enabled to do so much by the cordial encouragement and support they received from the inhabitants of the town and immediate neighbourhood, whose public spirit has been manifested throughout in an extraordinary degree. It has been mentioned that the harbour formerly belonged to the Magistrates and Town Council. Its revenues were then applied to the ordinary purposes of the Burgh, and this application of them enabled the magistrates to administer municipal affairs, and to defray the expense of watching, lighting, paving, &c. without any tax being levied on the burgesses and inhabitants. But so zealous were all parties in the design of extending and improving the harbour, that public meetings of the burgesses and inhabitants were held, at which it was unanimously resolved to adopt the provisions of the General Police Act, and so transfer the burden of lighting, watching, paving, &c. from the Burgh funds to the inhabitants, with the understanding that the administration of the harbour should be vested in Parliamentary Trustees, and its revenues devoted exclusively to its own purposes. And as the Burgh had contracted a considerable sum of debt, chiefly in the repair and improvement of the old harbour, it was agreed that such a moderate compensation as might meet that debt should be given to the magistrates and council for renouncing their right to the harbour and its revenues. Upon this footing, and with the magistrates and council for its promoters, the Act of Parliament under which the Memorialists were appointed was obtained. And it was not only in this instance that local exertions were made, and burdens submitted to, for when it became necessary to raise funds on the credit of the harbour and works, in order to carry out the intended improvements, those of the inhabitants who could conveniently do so advanced money on loan to a considerable amount, while many others came forward and gave their personal guarantees for repayment of the advances obtained on a bank credit in name of the Memorialists. The amount of the guarantees given by individuals in this way was not less than 24,000*l.*; and their obligations are still existing undischarged.

After all these exertions, there still remain of the works to be executed the *conversion of the inner or old harbour into a wet dock, and the deepening of the harbour and its entrance and approaches.* The former improvement may be deferred for a time at least, but the latter, *the deepening of the harbour and its entrance and approaches*, has become so pressing, and of such vital importance, that the Memorialists, under the circumstances in which they are placed, are constrained to take measures for bringing the case under the consideration of Government, in the hope that it may be held to justify and call for their interference and aid, as a matter affecting the public interest. The Memorialists, and the community with which they are connected, have done their utmost, and it is only after having entirely exhausted their own resources, that they ask for public support.

They have no remedy in a renewed application to Parliament for power to raise a further sum of money, because such an application would be unavailing, unless the Memorialists could show that

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their revenue warranted the outlay; and although Parliament were to grant the power, loans could not be effected without adequate security, which at present the Memorialists have no means of giving.

A plan of the harbour, as it now stands, accompanies this Memorial. Previously to the commencement of the recent improvements, the harbour was insufficient in every respect. There was a want of sufficient depth of water, and the quays and wharf walls were in bad order, and the jetty at the entrance was in a state of dilapidation. The want of accommodation, by reason of the smallness of the harbour, was such that it was frequently crowded to excess; at times the ingress was completely stopped up, and the trade of the town at a stand. The larger class of vessels had mostly to winter in other ports. These last-mentioned inconveniences have been in a great measure removed. The improvement effected by the Memorialists has for the present provided abundant accommodation within the harbour. But the complaint of a want of a sufficient depth of water in the harbour, and its entrance and approaches, remains in full force, and is the more grievously felt that it is a total barrier to the enjoyment of the advantages of the improved harbour. There is only a depth of 11 and 12 feet at the entrance at ordinary spring tides, and only 8 or 9 feet at ordinary neap tides. Vessels of 150 tons and upwards (of which there are a number belonging to the port) cannot enter or leave the harbour but at the height of the spring, and those of smaller burthen are often detained for several days waiting the tides. The works of the new harbour have been constructed in contemplation of the entrance, &c., being deepened from 4 to 6 feet, and were this accomplished, there would be from 17 to 18 feet of water at ordinary spring tides, in place of from 11 to 12 feet as at present.

The harbour is situated on the German Ocean, and on a rocky and dangerous coast. From the point at the extremity of the new return head of the sea wall towards the sea, the ground is quite flat for nearly a quarter of a mile till it reaches what is termed *the Bar*, beyond which the depth of water increases rapidly. The flat ground is quite dry in spring tides, and presents no difficulty to the deepening of the channel. That a safe harbour, accessible to vessels of considerable size, would at this point be of immense benefit to the extensive and populous district with which it is immediately connected, is perfectly obvious; and it is no less certain that it would be an object of national importance. The greater part of the east coast of Scotland is well known as presenting continued ranges of precipitous rocks; and with the wind on a lee shore, this coast is extremely dangerous. The entrance to the Tay is frequently no less hazardous, and the destruction of property and loss of life on the banks in that river have been of late years very great. From the body of fresh water issuing from the Esk and the Dee, and with the wind on the land, it is found difficult to take Montrose or Aberdeen. If, therefore, the projected improvements at Arbroath were completed, its harbour would be a great national benefit as a harbour of refuge to the whole east coast of Scotland.

Aberbrothwick, or Arbroath, as it is commonly called, is now a flourishing and populous town, the seat of extensive manufactures, and is daily increasing. In the year 1742 it contained only 2500 inhabitants; it now contains a population of about 15,000.

The old harbour was built about the year 1725, and had then belonging to it only a few vessels engaged in the coasting trade. During the year ending in October, 1843, which had been one of depression in the trade of the district, the number of vessels reported inwards from Foreign Ports was eighty-nine; and the total number of vessels that entered the harbour was 749. In 1727, the shore-dues of the Port amounted to 25*l.* 1*s.* 8*d.*; in 1746, they were only 20*l.* 16*s.* 8*d.*; in 1793, they were 293*l.*; in 1803, they were 370*l.*; in 1813, they were 731*l.*; in 1823, they were 615*l.* 15*s.*; in 1833, they were 1312*l.*; in 1843, they were 3050*l.* Further statistical details will be found in the accompa- documents, viz.:—

1. Abstract of shore-dues of the harbour of Aberbrothwick annually, from 1727 downwards.
2. Printed copy memorial and petition by the magistrates and others, to the Lords of the Treasury, for having Arbroath declared a free port—1844.
3. Abstract of the harbour accounts for the year 1840.
4. Ditto ditto 1841.
5. Ditto ditto 1842.
6. Ditto ditto 1843.

The Memorialists respectfully submit the present statement, with the view of its being made the means of drawing the attention of Government to the circumstances, and in the confident hope that if known and appreciated, these circumstances would be held sufficient to call for and justify a grant of public money for purposes so highly desirable and important.

JAMES GIBSON, *Chairman.*

Arbroath, 1st *November*, 1844.

ESTIMATE of the probable Expense of deepening the old Harbour of Arbroath two feet, and the new Harbour, with the entrance thereto, three feet, each Division being excavated, on an average, to these depths, although some parts may require more, and others less excavation, to give a fair and uniform bottom sloping regularly outwards to the deep water.

	£.	*s.*	*d.*
Old Harbour, 5,600 cubic yards, at 1*s.* 3*d.*	350	0	0
New Inner Harbour, 13,654 cubic yards, at 1*s.* 6*d.*	1,024	1	0
Outer Harbour, as far as the old Breakwater, 4,451 cubic yards, at 2*s.*	445	2	0
Channel out to the Outer Heads (chiefly rock), 4,155 cubic yards, at 2*s.* 6*d.*	623	5	0
Fairway beyond Outer Heads, widening out to 600 feet at the outer edge of the bar (rock and boulders), 28,666 cubic yards, at 4*s.* . . .	5,733	4	0
	8,175	12	0
Contingencies 10 per cent.	817	11	0
Say £9,000.	£8,993	3	0

JAMES LESLIE.

London, 29*th April*, 1845.

No. 15 *a.*

ACCOUNT of the ARRIVALS and SAILINGS of Foreign and Coasting Vessels, of 11 feet draft of water and upwards, at Glasgow Quay, during the Year 1844.—(Extracted from the books of the Harbour-Master.)

VESSELS.	11 feet	12 feet.	13 feet.	14 feet.	15 feet.	16 feet.	17 feet.	Total.	
Inwards, Foreign .	32	25	33	33	23	22	3	171	
,, Coasting .	155	66	6	2	..	..	..	229	
									400
Outwards, Foreign.	48	65	44	68	51	20	..	296	
,, Coasting	148	84	10	3	1	..	..	246	
									542
Total Arrivals and Sailings of 11 feet draft and upwards									942

In 1844 the number of arrivals, of all classes, at Glasgow Quay, was 13,919 Vessels. of 1,101,949 Tons.

Glasgow, 12*th July*, 1845. (Signed) JAMES JOHNSTONE.

No. 16.

No. 16.

Statement respecting the Forth Navigation to Alloa and Stirling.

Question 1836.—The guarantee which the Navigation Commissioners can give for payment of the interest of any money which may be advanced to them, and the repayment of the loan, are the rates authorized by the Act to be levied on vessels sailing between Stirling and Alloa, and the cargoes carried by them, and on passengers by steam-boats. The rates at present levied on vessels and goods are one-third only of those contained in the schedule of rates annexed to the Act; and no more than this third can be levied until 5000*l.* are expended for the purposes of the Act. On this being done two-thirds can be levied and no more, until a further sum of 4000*l.* is expended, and then the full rates authorized by the Act can be drawn.

The rates for the year from 15th May, 1844, to 15th May, 1845, were let for 350*l.*, and for the current year, from 15th May, 1845, to 15th May, 1846, they are let for the same sum to the same tenant, and he is considered to have a good bargain. Supposing, however, the rates to advance no higher, in present circumstances, being £350

Deduct for steam-boat passengers from whom the full dues are at present drawn .	100
	250
On 5000*l.* being expended this sum will be doubled (*being the second third*) . .	250
Add steam-boat passengers	100
	600
And on an additional 4000*l.* being expended another third, being the full rates, may be levied	250
	£850

From this it appears that were 10,000*l.* to be advanced by the Treasury for the purposes of the Act, at 3 per cent. there would be a sufficient revenue for the dues, *even although there were no addition to the present traffic*, to pay that interest, being £300

And a sinking fund for the redemption of the loan of 4 per cent.	400
	700
Leaving a surplus of	150
	£850

The above is the revenue that would be derived from the rates, even if the traffic remained stationary at its present amount. But that a very great addition would arise if the obstacles to the navigation were removed, there cannot be a moment's doubt. Even at present a number of large vessels carrying grain, timber, and iron, wool, &c., for Stirling, are obliged to unload their cargoes, or part of them, at Alloa, Grangemouth, and at a creek called Fallin, near Alloa, which are carted at heavy charges from these places to Stirling. From inquiries that have been made, the Commissioners have reason to believe, that traffic to an extent of not less than one-third of the present traffic by water to Stirling, is unshipped at the harbours below Stirling, and carted thereto. If, therefore, the loan required were given, and the amount laid out in the improvement of the navigation, there would, to the annual revenue which will be produced from traffic of the same amount as at present charged on vessels and goods at the full rates, being £750

And steam-boat passengers	100
Be added, the rates from the above additional third of vessels and goods, being .	250
In all	£1100

This is without taking at all into account the increased trade, which the facilities arising from the improved navigation would bring. In almost every instance this has been the result of improvements of other rivers; and the situation of the harbour of Stirling affords a certainty almost, of such being the case were the Forth improved. Situated as it is at the mouth of the highlands, in the heart of one of the most fertile and best cultivated districts in Scotland, of which Stirling is the chief town, and surrounded by numerous manufacturing villages, which are daily on the increase, there is no port which affords better prospects of becoming an important place of trade, if the access to and from it by the river Forth were improved, as recommended in the Report of Mr. Stevenson.

Question 1848.—The Commission asks the sources from which the present dues are derived? The

Commissioners of the Forth Navigation have been unable to procure an exact account of the *present* traffic, but they send herewith a copy of a statement of the entire traffic in the years 1840–41 and 1841–42, made up by the person by whom the old harbour dues were rented. This will give the Commission an idea of the kind of traffic, and also of the extent, and at present it is believed to be much the same, with a considerable addition on the quantity of limestone imported.

The shipping belonging to Alloa and Stirling, exclusive of three steam-boats, together 251 tons, of which one-half belongs to Stirling, and one-half to Alloa, is as follows:—

	No.	Tons.
To Alloa	99	17,392
To Stirling	24	1,048

But of those 99 belonging to Alloa a great many are not engaged in the trade to and from Alloa. Those belonging to Stirling are all engaged in trading within the bounds of the Forth Navigation Act. The number of arrivals and sailings of vessels to and from Alloa and Stirling for the year from 15th May, 1844, to 15th May, 1845, are as follows:—

	Arrivals.	Sailings.
From Alloa	526	520
From Stirling	806	806
From Alloa and Stirling, steam-boats	492	492

A great part of the sailings from Stirling are empty vessels which, after unloading their cargoes of limestones, building-stones, &c., depart immediately for a new cargo. These vessels are of comparatively small burden, which is absolutely necessary in the present state of the river; but if the fords were removed larger vessels would be used, from which a great saving would be effected by the lime-burners, farmers, builders, &c.

Stirling, 10th July, 1845. WM. GALBRAITH.

No. 17.

No. 17.

Her Majesty's Ship "Blazer," Grimsby,
18th June, 1845.

SIR,

I LANDED to-day on the Spurn Point with Mr. Calver, Master of the "Blazer," and Mr. Cubitt, C. E., to make the inquiries you ask for with respect to shingle.

We found seven vessels on the beach loading with shingle for road making, they were each about 60 tons, and can get a load in one tide. They pay 1*l.* per load to Sir Clifford Constable, the Lord of the Manor, for the privilege of loading, and 1*s.* per ton to the crew of the life-boat for getting the shingle on board. The price obtained for it varies, but may average 3*s.* per ton.

From all we could learn there appear to be on an average four or five vessels a-day loading on the beach, which would give, after making every allowance for bad weather, a larger quantity of shingle removed than the 35,300 tons mentioned in your letter.

The vessels are not allowed to touch the shingle within 300 yards on each side of the low lighthouse, in front of which the beach has changed very little since its erection on its present site.

The Spurn Point now appears to be stationary, but has, from the light-keeper's account, been diminished in width full half during the last 20 years.

I am, &c.
(Signed) OWEN STANLEY, *Captain.*

No. 18.

No. 18.

The actual Expense Paid out by the Contractor for Dredging Yarmouth Harbour, from April to December, 1831, *as furnished to Mr. Stead.*

	Tons.
Steam-engine raised	137,706
Horse-engine raised	71,844
Total	209,550

	£.	s.	d.	£.	s.	d.
Wages, working steam	209	2	7			
Labourage, landing	1,324	14	0	1,531	16	7
Or per Ton $2\frac{668}{1000}$*d.*						
Wages, &c., working engine (horse)	181	13	0			
Labourage, landing	673	16	3	855	9	3
Or per Ton $2\frac{858}{1000}$*d.*						
Raising 209,550 tons, costs				£2,387	5	10

Without any payment or allowance for wherries or punts used, (usually about $1\frac{1}{2}$*d.* per ton)—but the above includes all labourage, landing, &c.

Yarmouth, December, 1831.

AN ABSTRACT of the Account of Mr. Joseph Berry Edwards, the Treasurer to the Commissioners of Southwold Harbour, for the Year ending the 24th June, 1842, audited Quarterly by a Committee appointed for such purpose, 11 Geo. IV., c. 48.

	RECEIPTS.	£.	s.	d.		EXPENDITURE.	£.	s.	d.
					1841. June 24.	Balance due to Treasurer .	199	18	9
1841-2.—	Dues on 12,379 tons 9 cwt. coals, at 1s. 2*d*.	722	2	5	1841-2.—	Cash paid on various accounts, viz.:			
	Ditto on 26,230 qrs. corn, at 2*d*. .	218	11	8		For iron and blacksmith's work, &c.	100	3	11
	Ditto on goods, &c.	128	19	6		For labour, &c., as per surveyor's book	480	0	0
	Ditto on 2,330 tons of ballast. .	87	7	6		For interest on money borrowed .	54	16	10
	Tonnage dues	0	14	8		For salaries and law expenses . .	162	8	6
1842. June 24.	Balance due to Treasurer .	149	19	0		For timber, &c.	272	16	3
						For rope, yarn, oil, pitch, &c. . .	9	6	7
						For rent of office	10	0	0
						For stamps, printing, and advertisements	10	17	1
						For miscellanies	7	6	10
		£1307	14	9			£1307	14	9

The foregoing account was submitted to the Commissioners, assembled at their annual meeting, at the Old Swan Inn, Southwold, the 21st day of July, 1842.

(Signed) STRADBROKE, *Chairman.*

(Countersigned) HARRY WHITE, *Clerk.*

COMPARATIVE STATEMENT of the HARBOUR DUES paid by the Southwold and the Halesworth Trade during the last 30 Years, from Parliamentary and Harbour Returns.

Dates.	Southwold Trade.				Halesworth Trade.			
		Dues. £.	s.	d.		Dues. £.	s.	d.
1810	190,790 Qrs. Corn . . .	2,011	6	8	39,482 Qrs. Corn . .	380	9	0
1819	36,165 Chalds. Coals . .	2,976	8	8	26,897 Chalds. Coals .	2,236	0	0
		4,987	15	4		2,616	9	0
1820	243,302 Qrs. Corn . . .	3,041	5	6	71,843 Qrs. Corn . .	898	0	9
1830	34,221 Chalds. Coals . .	3,421	13	0	36,947 Chalds. Coals .	3,694	14	0
		6,462	18	6		4,592	14	0
1831	105,262 Qrs. Corn . . .	877	3	8	152,185 Qrs. Corn . .	1,268	14	2
1840	23,295 Chalds. Coals . .	1,811	16	8	46,397 Chalds. Coals .	3,608	13	6
		2,689	0	4		4,877	7	8

Expense and Method of Dredging.

Patrick Stead, Esq.

Perth, 23rd October, 1839.

DEAR SIR,

YOURS of the 19th received. We have again waited on the clerks of the River and Harbour Commissioners: they are of the same opinion as formerly—that the dredging cost only about 2½*d*. per ton. Annexed you have a calculation, by one of the Commissioners, who has taken a very great deal of trouble in this business for the last five years. The dredging apparatus and punts all belong to the Commissioners.

(Signed) WRIGHT AND CURRIE.

Report sent us.

The establishment under the Perth Harbour Commission, for dredging the river Tay, is a dredging machine, with a cover for 14 men: chief foreman, 5*s*. per day; second ditto, 3*s*. 4*d*.; the remaining 12 from 3*s*. 2*d*. to 2*s*. 7*d*. 24 punts, from 25 to 32 tons (average 30 tons), with a crew of 24 men: chief foreman, 3*s*. 6*d*. per day; second, 2*s*. 8*d*.; the remaining 22 from 2*s*. 2*d*. to 2*s*. 4*d*. Total wages per week, when full employment, 25*l*. The machine works during certain stages of the tide, and to load 18 punts is considered a fair tide's work, two tides work every 24 hours. Sometimes 23 punts have been loaded in one tide. The machine turns out not less than 5,800 tons a week for 30 weeks out of the 52. This quantity, at 2½*d*. per ton, is 60*l*. per week, leaving 35*l*. for coals, wear and tear of the machine and punts, interest of money, &c. Our time for deepening was five years, but we have got other two years given us—seven years altogether—so that I anticipate the lifting and depositing a ton of gravel will not exceed 2*d*. or 2½*d*.; and meeting with clay or sludge the work is somewhat retarded—if clay, 3*d*. to 4*d*.

P. Stead, Esq.

Perth, 9th October, 1844.

SIR,

THE improvement in deepening by cross dredging on the river Tay is in preference to dredging ahead. In cross dredging we only take about a foot in depth at a time, at the same time leaving the bottom as level as when we commenced; and by going over the shallows in spring tides, we come over it again when the tides take off, which gives a great advantage over head dredging. We can have a foot of water over a shallow in the half of the time, and likewise sure there are no ridges, stones, nor wood left to obstruct the navigation. At the rate our machine goes we clear about 680 square yards, one foot in depth, in a tide's work of five hours.

(Signed) JOHN NORWELL.

No. 19.

Mr. Chitty's Opinion as to Embankments.

CASE.

The Act of Parliament of 30 Geo. II. cap. 47, being "An Act for making the River Blyth Naviga-tion from Halesworth Bridge, county of Suffolk, into the Haven of Southwold," is left herewith.

Also the Act of 11 Geo. IV. cap. 48, A.D. 1830, being "An Act for more effectually improving the Harbour of Southwold," and whereby the former Acts of the 30 Geo. II. cap. 58, 29 Geo. III. cap. 77, and 49 Geo. III. cap. 77, are repealed.

Also the printed Report of Rennie, the engineer, of the 6th January, 1820, as to the encroachments and embankments which have been made and suffered, stopping up the creeks and narrowing, &c., the channel, and impeding the navigation of the said river Blyth, and thereby greatly injuring and blocking up the Southwold Harbour, and wherein he states the imperative "necessity of preventing such em-bankments for the future," and that to destroy the embankments already made, and to allow the tide-water to flow into its ancient receptacles, is the most obvious and effectual remedy that could be devised.

This has not, however, been done, the Commissioners having taken no steps whatever to remedy the evil and nuisance, whereby the harbour of Southwold has of late years been getting much worse than ever, so much so, that no water has ebbed or flowed in it for a week's continued duration. Vessels and crafts have been completely blocked up inside, and ships inward bound have been kept out driving about the roadsteads to their imminent danger, and compelled at serious risk to seek shelter in the neighbouring creeks, and are so at this present time lying beating upon the bar to their great damage and risk.

The Commissioners appointed by the aforesaid Southwold Harbour Act are almost entirely composed of land-owners and clergymen, having little or no interest in the commerce from whence the funds pro-vided for the reparation and good keeping of the harbour is derived, and the ship-owners and mercantile rights and interests have been so neglected to their grievous loss and injury.

It will be observed by Mr. Rennie's Report, that 1100 acres over which the tide used to flow have been embanked, of which 550 are ancient embankments and 200 more were embanked 50 years ago, and that the remaining 350 were embanked at the following later periods, viz, 100 in 1780, 100 in 1804, 100 in 1807, 43 in 1818, and that 200 acres are about the quantity now contained within the present embanked channels, creeks, &c., so that the force of the current has become diminished in the pro-portion of 10 to 4.

These encroachments and embankments are within the limits of the River Blyth Navigation Act They cause the injury complained of to the harbour, as will be seen by Mr. Rennie's Report.

Under the above circumstances, one of the gentlemen connected with the mercantile interest requests Mr. Chitty's opinion, with a view to adopt the most advisable measures for obtaining and compelling the removal of the embankments and obstructions, or for enforcing other sufficient remedy, and he also wishes to be informed fully of the rights and powers which he and the public have to effect that object, and how and by what process and at whose prosecution or suit it is to be obtained, and whether there is any and what limitation of time as respects any such penalties or responsibility.

And having referred to the General Harbour Act of the 46 Geo. III. cap. 153, A.D. 1806, whether such persons as have, since it was passed, made embankments without conforming to the provision, as to give one month's previous notice to the Secretary of the Admiralty, are not liable to penalty and prosecution, and what proceeding can now be taken, and by whom, and whether there be any limitation of time for commencing such proceedings.

Upon all the above matters Mr. Chitty's opinion is particularly requested, and he will much oblige us by citing or enumerating the names of the cases and reports thereof, or of the principal ones where any proceedings have taken place on the illegal acts above mentioned, both as regards encroachments and embankments, whether by information, indictment, action at law, or other-wise.

OPINION.

It appears to me, under the circumstances stated, that the embankments and obstructions in question are public nuisances, as being an injury to the harbour and the passage of ships. As such nuisances, they may be abated and removed; or the erectors or maintainers of them may be indicted, or have a criminal information filed against them; or if any individual has sustained any special injury arising from them (as by the detention of his ships in the harbour or the like,) he might maintain a special action on the case against them of these remedies. I should, at all events, for the present, advise the adoption of the one by indictment only, which may be prosecuted at the instance of any individual who may think fit to resort to it.

I should advise the indictment to be against the parties who have erected or maintained the most recent of the embankments causing the nuisance. I do not think that the length of time during which the embankments have existed will legitimize them: Weld v. Hoinby, 7 East, 195; R. v. Cross, 3, camp. 227; Coupland v. Hardingham, id. 398; Voogbt Winch, 2 b. and ac. 662.

There is no limitation of time for the prosecution by indictment. The responsibility to an action at the suit of any party specially injured, would cease at the end of six years from the occurring of that injury.

Those persons who erected the embankments since the 46 Geo. III. was passed may, I think, have subjected themselves to the penalty imposed thereby.

The following Statements are those referred to in Question 1362 *(Lieut. Ellis's Evidence).*

James Fisk, aged 64, marshman, states that for the last 28 years he has worked wholly for the Earl of Stradbroke. Recollects the enclosing of the Bulchamp Marshes about 40 years ago, and worked at it. Before the embankment began, he was at work at Southwold, opening the harbour, which was then blocked up, so that ten waggons abreast might go across there. The harbour, was in that state for some weeks, and was occasioned by the N.E. wind, and continued until a N.W. wind came. Never heard any remarks made at the time of the enclosing, nor don't know of any difference in the harbour from the embankments. The tide is now as good and strong as ever it was. About half the land was covered with water, and at high water spring tides the whole was covered about one foot. The water runs up in the river now as high as ever it did.

Blythborough, July 8, 1844.

James Sterry, aged 81, formerly a Trinity Pilot, now deputy harbour master, and many years principal harbour master. Sixty years ago, used to lighten vessels in the roads drawing eight or nine feet to enable them to enter the harbour, and outward bound vessels were obliged to load up outside the harbour. On one occasion, when a hoy, he laid 12 weeks in the harbour ready for sea, in a vessel drawing 8½ feet water, laden with corn. The embankments made in his time, made no difference in the harbour. In 1784–5–6, the harbour was worst in his recollection, a lighter was built expressly for lightening vessels, to enable them to get over the bar, and coal vessels coming from the north, were entitled to the turn according as they arrived off with the High Street open.

Southwold, July 8, 1844.

Return of Books of Account kept by the Officers under the Commissioners of Southwold Harbour, and produced before the Tidal Harbours Commission.

1. *Treasurer's.*—Debited with the collections paid by the collector, and other receipts, and credited with the payments for timber and materials, labour, salaries, interest of money borrowed, and all other outgoings.

2. *Surveyor's.*—Debited with the checks drawn on the treasurer, and credited with the amounts paid weekly for wages of carpenters and labourers, dredging, &c.

3. *Surveyor's Materials' Book.*—Debited with the supplies of timber and materials, and other property of the harbour, in which are noted the cost, marks, quality, and dates of the articles received, and credited with the same when expended. The stock is taken periodically, and the articles shown how and for what purpose expended.

4. *Collector's.*—Debited with the amounts collected for harbour duties, and shown in detail, and credited with the payments made to treasurer; and a return made to treasurer of amount paid by each vessel, for him to check the same with the arrivals and sailings.

The treasurer gives bond in the amount of 3000*l.*, and the collector 300*l.*

The accounts are audited quarterly by a committee appointed at each annual meeting; and all bills are submitted for inspection and allowance before they are paid.

Francis W. Ellis.

London, June 4, 1845.

No. 20.

No. 20.

Extracts from Mr. Rennie's Report on Southwold Harbour.

London, January 6, 1820.

There is little doubt that the harbour of Southwold has, at former periods, been of a much greater depth than it now is, as will hereafter be shown; and that, for many years past, it has been getting gradually more shallow, owing to the embankment of the salt marshes, over which the tide used to flow, and the stopping some of the creeks which communicated with the channel of the river Blyth. By these changes the influx of the tide-water has been diminished, and, consequently, the efflux, thereby diminishing the velocity of the current, so that the matter, which formerly was not sufficiently heavy to resist its strength, gradually became so. Thus, not only shingle and sand brought in by the tide, but also alluvial matter, brought down by the freshes of the Blyth, subsided, and gradually lessened the depth of the channel; and this evil continued increasing, until the force of the current became just equal to the removal of what more had a tendency to settle. In this state it will remain until the current is increased by freshes in the river, by high tides, or by heavy gales of wind; these will occasion a change in the channel for a time, but it will return again to the same state, unless the quantity of matter thrown in by the sea is of too heavy a nature to be removed by the power of the land-water, assisted by the returning tide, which, in time, will become consolidated, and must be removed by artificial means.

I have not proofs of actual soundings, to show what was the original state of this harbour, because Collins, in his Coasting Pilot, the best early charts I know, and of which I am in possession of the original edition, published in 1693, gives no chart of this harbour; but I learn from documents in the possession of Mr. Jermyn, who has obligingly favoured me with them, that about 1100 acres of ground, over which the tides used to flow, have been embanked; of these about 550 are ancient embankments, 200 were embanked about 50 years since, 100 in 1780, 100 in 1804, 100 in 1807, and 48 acres in 1818. Some of these enclosures lie at the distance of between five and six miles from the mouth of the harbour, but the greater part of them are at Blythborough, about four miles distant from it; that the average rise of water there is about five feet, and the tides used to cover them about six inches; this, however, was important, because, as the tides continued to flow for about two hours there, after it began to ebb at the mouth of the harbour, the greater body of water returned at the last quarter of ebb, when its scouring effect is the greatest; and, when the small rise of tide here is considered, every inch that can be obtained is the more important.

From the best information I have been able to obtain, good spring tides rise at Southwold Harbour six feet six inches, neaps about four feet six inches, but frequently not more than four feet; thus making an average rise of about five feet six inches, so that the tides at Blythborough rise nearly as much as they do at Southwold; the quantity of surface contained within the present embanked channels of the river Blyth, creeks, and low embanked ground connected with it, as far as I can ascertain, may be about 200 acres, on a part of which the tide may rise five feet on the average; on others, not two feet; perhaps if four feet are taken it will be a full average; and if six inches only are taken as the average height, that the tide formerly flowed over 1100 acres now embanked, the diminished force of the current will be nearly in the proportion of ten to four; this is confirmed by the evidence of John Church, formerly a branch pilot, but now master of a vessel, and who has been about 52 years at sea. He said that about 30 years ago the current of ebb was so strong, that they were obliged to make the vessel fast by cables, and a boat could not pull up the harbour; but that now a vessel could stem the current with a good tow line, and a four-oared boat could row up at any time.

I have been thus particular in stating the evils arising from embanking the marshes, over which the tide used to flow, that I may impress on your minds the necessity of preventing such embankments in future, unless a receptacle is made somewhere else in lieu of the embanked lands; for, unless this is strictly attended to, the harbour will go on getting worse, until it be entirely lost, and I am not aware that any remedy can be substituted for the deprivation of backwater.

No. 20 *a*.

Mr. Walker's Report on Southwold Harbour.

SIR,

23, *Great George-street*, *August* 25, 1841.

YOUR letter of the 29th October, 1839, informed me that the Commissioners of Southwold Harbour were desirous of my "examining the state of that harbour, and advising on the best means for its improvement."

Having learned that there were no correct plans or sections of the harbour nor of the river Blyth, at the mouth of which the harbour is situated, I wrote to you on the necessity for such, and I had the authority of the Commissioners to send down a surveyor for the purpose of making the survey, plans, and sections.

In March, 1840, Mr. Wright, with Mr. Drane as his assistant, proceeded on the survey; and in consequence of a subsequent arrangement with the River Commissioners, to which you were privy, Mr. Wright was directed to extend his survey so as to include the river up to Bulchamp Lock, $6\frac{3}{4}$ miles from the harbour. This being a work of considerable time and labour, the survey and rough plan and sections were not completed until Midsummer, 1840; and Mr. Wright has since furnished me with his Report, consisting of a detail of facts which have been most useful to me in preparing the following Report; and also with his opinions on the different points, which prove that his attention was not confined to the mechanical part of the survey.

On the 3rd October last, Mr. Drane accompanying me, I visited Southwold, where I attended a meeting of the Harbour Commissioners; the Earl of Stradbroke, chairman; and afterwards, and on the following days, I surveyed the harbour and the river up to Halesworth. In this I was aided by Lieut. Ellis, R.N., harbour master, who rendered me all the assistance in his power. Mr. Drane, and Mr. Sterry, the assistant harbour-master, accompanied me up the river. At Halesworth I had a conference with Mr. Stead, the principal merchant of that place, and the most active of the River Commissioners in harbour and river matters.

Since then I have had two fair copies of the plans and sections made; one copy for the Harbour, the other for the River Commissioners. These will be delivered with this Report, and both Commissions will then be in possession of a document, on the accuracy of which, from Mr. Wright's knowledge and great experience, I think they may depend.

You are aware of the difficulty that has attended every inquiry into the former state of the harbour and river, from there being no plan to refer to previously; and you will, I think, agree with me, that the removal of this difficulty henceforward, is, of itself, an important object gained.

It remains for me now, after stating from my own and Mr. Wright's observations, the leading facts and phenomena of the harbour and river, in their present state, which will also be useful for future reference, to give my opinion of the most eligible course for their improvement.

Southwold.

The town of Southwold, containing a population of about 2000, is situated on the nearest rising ground, north* of the entrance of the river Blyth, and is about half a mile distant from its harbour.

The only manufacture carried on is that of salt, the warehouse and boilers for which, are situated at the head of Salt Creek, or at the lower part of the town. The channel of the river, at the point where it enters the North Sea, nearly at right angles to the general line of the coast,—forms the harbour of Southwold. The direction out of the harbour between the two piers is south-east; the direction across the points of the piers is at right angles to the above, or south-west and north-east. Thus as respects either the coast line, or the direction of the entrance, the piers may be said to be of equal length. Both piers are chiefly of fir-timber, nearly parallel to each other, and 115 feet apart (the width of the entrance) at their outer ends.

Tides.

At the harbour, high-water at full and change, takes place at half-past ten o'clock: the best springs are a few days afterwards, at two o'clock, thus the afternoon spring tides, and these only, are in good day-light throughout the year. The tide of flood in the channel, runs to the southward from half an hour after low-water, to half an hour after high-water; hence the northerly winds raise the tides, and the southerly winds keep them back; but the lift of the tide here, as every where upon this coast, is small

A tide gauge is fixed near the entrance, the bottom, or zero, level with low-water of spring tides. A good spring tide rose $6\frac{1}{2}$ feet above this mark; 2 to 3 feet higher is a very high tide; 8 to 9 feet is therefore the greatest rise of tide above zero on the index; and as some very low tides ebb 1 foot under zero, 10 feet may be taken as the extreme lift of the tide, and 6 feet 6 inches that of an ordinary or average spring tide. Neap tides, which seldom ebbed so low as zero, rose only 3 to 4 feet above it.

The average of 80 tides, taken during the survey, reached 5 feet 3 inches upon the index,† but as the average low-water was above zero on the index, the average lift of all tides would be about 5 feet.

Similar indexes were placed at the same horizontal level at the west end of the south pier; at Blackshore Quay, three-quarters of a mile from the harbour's mouth; at Reydon Quay, one mile and a quarter higher, at Blythburgh Bridge, four miles; and at Bulchamp, the first lock, six miles and three-quarters from the harbour.

An observation was made at all the above points, during the rise of a spring tide, and repeated at a neap tide: in both cases it was found that the water at all the places reached the same horizontal level. Winds would no doubt produce some, but in this narrow river not much effect in sending up or keeping back the flow, but the above observation, that the tide at high-water reaches the same level at all places within its reach, is important, as showing that not much in the way of rise of tide is to be expected from any straightening or widening of the river.

Observations of the same two tides were made at low-water; and it appeared that at dead low-water, the tide at the harbour's mouth ebbed only 1 foot lower than at Bulchamp Lock. Thus the average lift of all tides at the latter place may be taken at about 4 feet, that of spring tides $5\frac{1}{2}$ feet, and of extreme tides, upwards of 7 feet.

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* All the bearings are given by compass; the variation is 23° 30′ west.

† These Indexes should be fixed very permanently and preserved very carefully.

APPENDIX.

No. 20 *a.*

The times of high water at different stations up the river, were later than at the harbour as under:—

At Reydon Quay, 2 miles from the harbour, 25 minutes.
At Blythborough, 4 miles from ditto, 35 minutes.
At Bulchamp, 6 miles from ditto, 50 minutes.

Low-water at the Harbour was earlier than

At Reydon, by 30 minutes.
At Blythborough, by 70 minutes.
At Bulchamp, by 120 minutes.

The time of the tides ebbing, is about half an hour longer than that of flood. The current of a spring tide near the harbour continues to run up the river about half an hour after high-water.

The velocity of the ebbing tide towards the inner ends of the piers at the entrance of the harbour, where the width is suddenly contracted by the banks of shingle thrown in by the seas, reached, in places, four miles per hour, at very high tides; the greatest run out of the harbour being between the second and the third quarter of ebb; while the flood of the same tide at no time exceeded two miles per hour, the greatest velocity being between the second and third quarter of ebb. Opposite Reydon Quay, the velocity did not at any time exceed two miles; at Blythburg, the rate was three-quarters of a mile; and decreased gradually up to Bulchamp Lock.

The greatest velocity of the flood tide at sea, observed by Mr. Drane, at two miles from the shore, was, in springs, three miles, and in neaps, two miles per hour; the direction of the current, south-west, that of the ebb, north-east, with nearly the same velocity, and both diminishing gradually towards the shore.

Sea-borne vessels not exceeding 200 tons, or drawing above nine feet water, can enter with a spring tide and unload their cargoes, chiefly at Blackshore Quay, which belongs to the Corporation of Southwold, and is three-quarters of a mile from the entrance; and some few go no higher than Walberswick Quay, which is on the south side, and half a mile lower; others go to Reydon Quay, two miles from the harbour; which last place, as will be seen by the sections, vessels of equal draught can reach.

At these quays the cargoes are either landed for the town and neighbourhood, or transferred to wherries, drawing about four feet water: these take the coals and other cargoes up the open river to Bulchamp, and thence by the aid of six locks of 14 feet width, in the river to Halesworth, which is four miles above Bulchamp.

Halesworth has a population of 2,500 to 3,000; it is a thriving town; considered one of the best situated corn markets in the county: its present export is stated at 29,000 quarters, and to be capable of great increase, if the navigation were improved.

Mr. Stead informed me, that at present the uncertainty of the corn getting to market, arising chiefly from the state of the harbour, is very great; that the detention amounts sometimes to three months. Hence the great desire of the Halesworth merchants for a removal of the obstructions, the greatest of which is undoubtedly the Bar opposite the mouth of the harbour; and after this, the want of water up to the quays; for crooked and narrow as the river is at present, the passage from Halesworth to the vessels and up again with coal from the vessels, does not usually occupy more than one day.

The Shoal.

“Immediately that the current out of the harbour gets from between the piers, and meets the resistance of the sea water, its velocity is checked; it spreads out on each side; and the current, which between the piers was three to four miles per hour, is reduced one half, and its direction being controlled by the winds and tidal current, is uncertain. The sand and shingle, which have been carried in between the piers by the flood current, and deposited where that current slackens, are afterwards by the ebb tide carried out of the harbour and lodged at its mouth, where the effluent current diminishes in velocity, and can carry them no further. This forms the shoal water in front of the entrance.

The Bar.

But, as respects the bar, it is principally caused by the shingle which is moved along the coast by the action of the waves in a southerly or northerly direction, according to the wind; and which, when it comes round the end of the pier, the force of the ebbing current is not sufficient to drive away, so as to keep clear the harbour's mouth.

As the strongest current out of the harbour is at three-quarter's ebb, when the cross tide upon and near the shore is running from south to north, the combination of the harbour and shore currents takes the direction of east; in this direction, therefore, there is generally the best water into the harbour; and the harbour is very seldom, if ever, closed by the bar, when it is formed by the south wind round the south pier; but, with northerly winds, the harbour is occasionally entirely blocked up for the whole width of the opening, the shingle-bank reaching for many yards within the pier heads, and nearly to the level of the top; and it remains closed until a change of wind takes place, when a cut has to be made by manual labour.

The current out of the harbour is further checked by a ridge of sand which runs along the coast about 250 yards from the shore. On the north of the entrance this sand is called the “Hayle Sand,” and on the south side the “Mill's Knoll Sand.” In so far as this sand acts as a breakwater to break the force of heavy seas from the entrance, its tendency is beneficial. The entrance of Southwold is, however, little protected in this way, compared with Yarmouth; and this is another disadvantage under which Southwold labours.

The bar is the great evil of Southwold harbour, as well from its shifting nature as from the small depth of water over it. It is composed of shingle, which, in this as in many other parts of England, forms the great obstruction to the entrances of harbours. It lines the shore; and, as the stroke of the waves upon this moveable body is oblique, to the north or to the south, according to the wind, the shingle is moved slowly along in either direction. In northerly winds, the shingle, after the space at the back of the north pier is filled, wraps round the end of the pier and comes in front of the entrance; and, as the wind continues, more and more is brought round, until a shingle-bank (the bar) is formed, in a crescent shape, nearly quite across the entrance; and the entrance would be very soon entirely blocked up but for the ebbing current of the river forcing its way to the sea through the shingle. In this case the entrance, or deepest water, must be close to the south pier. This is “the south passage.” The operations of southerly winds produce the similar but opposite effect round the

Appendix.

No. 20 a.

south pier, and then the passage is necessarily close to the north pier. But the greatest inconvenience is caused by the north and north-west winds, which are prevalent, and come more in the way to prevent the harbour-current from falling in with the tide upon the shore than the southerly winds do. When the wind is directly upon or off the shore, the passage is straight out in the line of the piers, which are then comparatively free of shingle; the bar is then detached from the piers in front of the entrance, with a passage on each side, but in such case the action of the effluent current is weakened by being divided.

The level and direction of the bar are so very variable that, before a vessel of any considerable draught attempts to enter, soundings have to be taken, and she is warped in through the narrow channel. The delay is often very great, and so also must be the danger to a vessel riding off upon a coast which has not the advantage of a roadstead, formed by the sands in front of it, as Yarmouth has. The losses have been numerous; and that the trade should continue as it is, notwithstanding these drawbacks, is proof that there are advantages in some other respects; probably the situation of Halesworth, in respect of the corn-growing country around it, is the principal.

The present revenue of the Commissioners was stated to be about 1100*l*. per annum, and to be rather on the increase.

On reference to the plan, it will be seen that the bar, as given by Mr. Wright, is detached from the piers, and is in no point above the low water of average spring tides (zero on the index); but there were times, during the survey, at which the bar was dry at half ebb. Indeed, the situation and shape of the bar, and the depth of water over it, depending entirely on the direction and strength of the wind, are so variable that it was impossible to take soundings near the mouth of the harbour which could be depended upon as correct for two days together. Before and at the time of my survey the southerly winds had been prevalent, the bar was therefore in front of the entrance, and round the south pier; the only passage, therefore, was close round the north pier.

I think it better to add, by way of Appendix, to which I beg to refer you, the principal evidence I received in respect of the bar, and its present condition, as compared with former times, than to embody it in my Report.

It appears generally agreed that the harbour has not been so frequently blocked up at any time since 1830 as it occasionally was previously to that time; and the very useful work done by order of the Commissioners, under Lieutenant Ellis's direction, of straightening and deepening the channel immediately inside the piers, by cutting through the Bellar, has been instrumental towards this, and towards facilitating the passage of vessels by substituting a straight for a very tortuous channel.

After getting over the bar and between the piers there is now a straight passage up to Blackshore and even Reydon Quay, with nowhere less than 4 feet 6 inches at low water, or 11 feet at high water of spring tides; in most places 2 to 3 feet more; while the bar is still occasionally dry at low water of the same tides; and the entrance is subject to be entirely blocked up by a continuance of northerly winds. The pilots, as will be seen by the Appendix, consider the north-west winds, producing what is called the north-west "swipe," (the sweep of the wave along the shore,) as causing the worst bar of all.

Piers.

The north pier seems to have been repaired at different times, but not to have been lengthened since its first formation; it is close-piled on both sides. The south pier has been lengthened 30 feet: the old head is still visible. This pier is close-piled on the north or harbour side only.

That the distance between the piers, or width of the entrance, is too great for the current to keep clear is very evident; but if its width were no greater than the current would clear, it would be too narrow for a vessel to enter in rough weather. There is a choice of evils; and, on the whole, I do not think that contraction of width would be an improvement to such an extent as to render it, under the circumstances, desirable to take down or remove the present piers; but were a considerable extension in length to place, it would be advisable, both as respects the velocity of the ebbing current on leaving the piers and the quieting the harbour within, to *kant* the ends so as to contract the opening to about 80 feet at the points of the piers.

Extension of Piers.

The opinions on the effect of lengthening the piers are very various, some arguing for the extension of the south pier, others for adding to the north pier, some for the extension of both piers, and others for their entire removal. The last opinion is the farthest from mine of any. The experience of harbours generally is against it, and the reason is evident, for it is by the piers that the stream of the effluent water is kept in the same place and course, and prevented from spreading about and shifting as the waves move the shingle and sand in the one or other direction. The history of this, and of most other rivers, particularly when their power is not great, proves this. We are told and shown that their mouths have been at times some distance on either side of the present situation; and there is little doubt that they, and the Blyth also, would again alter if the piers that now confine them in one direction removed. Without therefore, calling in aid the argument that the piers of Southwold Harbour act as a groyne to stop the shingle and protect the town and coast (which they do), the idea of taking down the piers should be abandoned for the harbour's sake.

I have as little doubt that their extension would do good by confining and directing the current into deeper water, carrying the shingle into a stronger tide, and diminishing the distance between deep water and the river. To produce these effects both piers should, I think, be carried out an equal length. No practicable extent of lengthening would prevent the shingle from collecting at the back of both piers; after the space behind them becomes filled, it will come round and in front, as at present; but as the shingle moves in both directions, depending on the wind, I see no reason why, in this view of the matter, the one pier should be advanced before the other. Suppose both piers extended 50 yards, a prevalence of northerly winds (the north "swipe") would tend to bring the shingle round the end of the north pier, and in front of the entrance; and the south pier, if extended also, would tend to press the out-going current against it, and to keep the harbour open; but if in such a case of winds the north pier only were extended, the current out of the harbour, resisted by the shingle in front, and not confined by a south pier, would take an oblique or southerly direction, and its diminished force would be spread over a greater space upon the shore, which would lessen the depth and therefore be detrimental. The inside of the north or longer pier would also form a lodging place for the shingle brought from the southward in southerly winds, which, if the piers had been of equal length, might have passed round clear of the entrance.

The result would be similar if the south pier alone were extended, with this difference however, that the harbour current, in the latter case, would be in the same direction as the ebbing tide along shore, say northerly, and would fall in with it; whereas, in the former case, it would be opposed to it. It is not improbable that the experience of this evil led to the addition made to the south pier, when the north pier was 10 yards in advance of it.

My opinion then is, that it would be desirable to extend both piers, but that if there be any difference, the south should extend beyond the north one. In the present state of the harbour revenues, I fear that this might be considered an expensive work. From a general estimate I do not think it would be less than 20*l*. per lineal foot of each pier.

Embankments.

On the injurious effects produced by embanking the low land, there is a greater unanimity of opinion, as appears by the evidence which has been transmitted to me, of the captains of vessels and others; and as respects the entrance and the harbour below the embanked part, there can, I think, be no doubt of the fact. If there were no River Blyth nor receptacle for tidal water to pass in and out at every tide, the harbour would cease to exist. The area of the entrance, as respects its width and depth, is the balance of the velocity and quantity of water which passes between the piers on the one side, and of the resistance already referred to on the other. If with the same width between the piers we reduce the quantity of water which has to pass in or out in the same time, we diminish at once the required velocity or power to remove obstructions, and a decrease of depth follows almost immediately. This evil may be counteracted by the formation of piers to confine and direct the current, and by other artificial means, so as to make the smaller quantity do as much good as the larger did before; but with the same improvement of piers the larger quantity would have done more good. It is in this way that the evidence of Masters, taken in 1839, is to be reconciled with that taken by me. The former has regard to the black side only, and to the injurious diminution of velocity from four to one and a half or two miles per hour, in which I fully agree. The latter refers to the state of the entrance generally, to the piers in their present condition, and to the useful straightening and improving of the harbour inside the piers by removing the Bellar Shoal and confining the width.

By Mr. Wright's measurement, of which an abstract is given in the Appendix, showing the area and level in each division, it appears that the whole area within his survey, formerly overflowed by the tidal waters of the River Blyth, was at every spring tide nearly 2000 acres, exclusive of the Dingle, Westwood, and Dunwich marshes, about 1200 acres of which are considerably below the level of a spring tide; and as they had no other outlet, should be considered as having formed part of the old estuary of the river or backwater of the harbour. By the embankments this area of 2000 acres is reduced to 450 acres, the area from which the tide is excluded being thus 1550 acres. Over a portion of this the depth would be small even at spring tides, but over more than half the area it would exceed two feet, and in cases of very high tides and land freshes, double this or four feet. The last large enclosure was that of Bulchamp new Saltings, 105 acres, in 1804, the level of which is three feet under an average spring tide. The deduction from the quantity of backwater is not confined to what is actually embanked, for the reduction of the estuary by stilling the water upon the space between the present river banks and the channel of the river allows that part to silt up, so that its level is now up to the high-water of spring tides, or several feet above the reclaimed ground within the banks. While the injury done to the entrance of the harbour and to the harbour itself is certain, it may be that the river opposite the embanked parts is not injured, but, on the contrary, improved; this is the case generally where the river depends more upon the land than the tidal waters, by confining the width and thus increasing the scour. In this instance, where the land water is small, I do not consider the river improvement, effected in this last way, as by any means equal to the injury done to the harbour.

It is to be lamented that when the owners of estates were perhaps balancing in their minds whether the land they could reclaim would pay the expense of reclaiming it, they were not advised of the injury they were about to do to the public and themselves by the reduction of the backwater, upon which their harbour is dependent; this would probably have decided the question and prevented the execution of the work without other interference. That many harbours have thus suffered through ignorance or neglect, at least as much as through the desire to obtain property, is probable. In the present case, to destroy the banks of the parties who have been allowed to exclude the water—some upwards of a century, none it appears less than 36 years—and who have been, perhaps, at great expense in draining and improving the surface, would, even if lawful, be such a hardship, and would be so opposed on its own account and as a precedent, that I apprehend this is practically out of the question. The same principle, applied in its full extent, would lead to the removal of the locks, which also exclude a portion of tidal water. It would be much better, I think, to take these encroachments as having the sanction of time, and to consider what is best under existing circumstances, taking care however to prevent the further reduction of the backwater; and the present question is what, if anything, can be done for improving the harbour or the navigation upwards in the way of substitute for the reclaimed land or generally.

I have already referred to the extension of the piers, and I know no surer way to improve the entrance of the harbour than by reducing its greatest evil—the bar. On principle it is correct, and in most other cases has been successful. Would the proprietors of land assist in this? Although they may not at first sight feel so interested in this as the merchants do, a little consideration will show, I think, that they are more so; as in the price which the merchant gives the farmer for his corn, he considers and deducts for the risk and probable delay, and he adds to the price which both landlord and farmer have to pay for their coals and merchandize. Without knowing the fact, I should expect that the same quality of corn in a market as near the entrance of Yarmouth Harbour as Halesworth is near Southwold, will fetch a better price; and if the Southwold quantity be calculated at the difference, the sum may probably amount to much more than the landed interest would be expected to contribute to improve the harbour; a portion they might, and on the score of justice the owners of the reclaimed land might be expected to be the first to come forward.

Deepening and Dredging of Rivers.

After this, the deepening and improving of the river and creeks is the most feasible, and in this the owners of the low lands, liable to be injured by winter floods, are peculiarly interested; as whatever improves the navigation in this way, improves the main drain of the country, and takes off the land floods more rapidly.

There is, I understand, some questions as to boundary between the districts of the Harbour and River Commissions. Any doubt of this kind should not stand in the way of improvement, as their interests are almost identical. The dredging done by Lieutenant Ellis did not reach higher than Blackshore Quay; and in the whole of this length, from the inside of the piers to this quay, and above this to Reydon Quay, there is everywhere, except at the Ferry Shoal, at least six feet at low-water. From Reydon Quay to Blythborough Flats, a length of one mile and a half, the depth is at least five feet at low and eleven feet at high-water: there, therefore, little is required. It has been proposed to cut a straight course through the bend at Blacksend Reach, which I am not disposed, at least under present circumstances, to recommend, as its tendency will be still further to diminish the backwater, by allowing the present channel, which is longer and wider than the new one, to silt up. Indeed, although there are several similar bends up to Blythborough Bridge, I would recommend that the present course generally be deepened and widened; the very sharp angles and points cut off; and the steep banks sloped back, in preference to new cuts. A bottom width of 30 feet, and a depth of at least 6 feet at the high-water of neap tides up to Bulchamp Lock, would give great facility, and at a comparatively moderate expense.

Blythborough Bridge.

Blythborough Bridge, in the line of the turnpike road, is a great nuisance; the whole height between the soffit of the arch and the ground is only 10 feet: when a spring tide is in, there is only 4 feet above the water; and at the high-water of a neap tide only 4 feet of water. It is a disgrace to the navigation and the county, and ought not to be tolerated another year. I can only suppose that it is owing to some mixed interests, and consequent want of understanding, that it has been left so long. A cast-iron flat arch, of 35 or 40 feet span, would, I apprehend, be sufficient.

If the river generally were deepened, the sill and chamber of Bulchamp Lock should be lowered. At present, there is only 5 feet over it at high-water of spring tides, or 4 feet at neaps, when the wherries drawing 4 feet can enter only at the top of the tide.

Salt Creek for Basin, &c.

The next and last improvement I would name, is the enlarging and deepening of Salt Creek up to the town of Southwold, although I fear it may be some time before this is accomplished. I have seldom seen so good an opportunity of making a snug basin as this presents, if the trade of Southwold would afford it. At the same time, by means of a pair of gates on the balance principle, or even common gates with sluices, a very useful addition might be made to the back-water, for the benefit of the entrance to the harbour. The water would all be let out at the best time of the ebbing tide, when the effect, from its proximity to the entrance, would be considerable.

My opinion finally is, that although Southwold will never be a very important harbour, it is capable of improvements which would much increase the trade of Southwold and Halesworth, and the value of all the property, of which the harbour is the outlet; and that the first step towards this is a perfect understanding between the Harbour and River Commissioners. There may be reasons, of which I am not aware, that prevent the two forming one Commission, but I am sure that the interests are almost the same.

I am, Sir,
Yours most obediently,
JAMES WALKER.

To Harry White, Esq.,
Clerk to the Commissioners of Southwold Harbour, &c.

TABLE, showing the Area of the Embanked Lands, formerly overflowed by the tidal waters of the River Blyth; with their Situation, and Level below a 6-feet 6-inch spring tide; and the Quantity of Backwater excluded thereby from scouring the Harbour.

Parish in which situated.	No. of Acres reclaimed, including walls, &c.	Average level below a tide of 6½ feet.		Cubic feet of water excluded.
	Acres.	Ft.	in.	Cubic ft.
Southwold	171	3	3	24,208,470
" New Marshes . .	36	0	6	784,080
Reydon (from Wolsey Creek) .	254	3	6	38,470,840
Reydon with Easton . . .	94	1	9	7,165,620
Walberswick	79	2	6	8,603,100
"	146	1	9	11,129,580
Blythborough, east of bridge .	83	2	0	7,230,960
" west of ditto . .	72	1	0	3,136,320
Bulchamp	150	2	3	14,701,500
"	105	3	0	13,721,400
" N.E. of Blythburgh .	80	2	6	8,712,000
" N.W. of ditto . .	86	1	9	6,555,780
" at Bulchamp . .	58	0	6	1,263,240
" south side of river .	60	0	9	1,960,200
Wenhaston	30	0	6	653,400
——	1,504			148,296,490
Dunwich, Westwood, and Dingle Marshes	1,200			
	2,704			

No. 21.

Report on Southwold Harbour and the River Blyth, by an Admiralty Surveyor on the East Coast of England, to the Secretary of the Admiralty.

H. M. S. Blazer, Harwich, August 1, 1844.

SIR,

Admiralty Orders.

IN obedience to their Lordship's directions, to report on the past and present condition of Southwold Harbour, I have the honour to state that, having given notice of my intention to Lieutenant Ellis, Harbour Surveyor, and to the authorities, on the 8th July last I proceeded to Southwold, where I met several of the Harbour Commissioners, the Harbour Surveyor, Mr. Stead, merchant of Halesworth, with the steward and agent of Lord Stradbroke and Sir Charles Blois, the two principal landed proprietors on the banks of the river Blyth; and in their presence I took the evidence of the old pilots, masters of vessels, and wherry or lightermen, as to the former and present state of the harbour and bar.

Evidence of pilots, &c. at Southwold.

Map of River Blyth.

I was furnished with a copy of Mr. Wright's large map of the river Blyth, on the scale of 20 inches to a mile, made for Mr. Walker's survey in 1840; a valuable document, highly creditable to the surveyor who executed it, and to the public spirit and liberality of the Harbour and River Commissioners, at whose joint expense it was made. This plan greatly facilitated my inquiries, and in all future proposals for the improvement of the harbour it will be found of the greatest utility. A reduced copy of it accompanies this report.

On the following morning, in company with Mr. Calver, master and assistant-surveyor of the *Blazer*, Lieutenant Ellis, R.N., and Mr. Stead, one of the river commissioners, I examined the bar, the harbour, and piers, and rowed up the river Blyth as far as the Bulchamp Lock, a distance of about five miles and a half.

Evidence of wherrymen, &c.

At Blythborough Bridge I met Mr. Johnston, banker of Halesworth, and Colonel Bence, usually Chairman of the Harbour Committee of Management, also river commissioners, and received the evidence of other wherrymen and navigators employed on the river, as well as that of Mr. Stead's agent.

Acts of Parliament, Reports, &c.

Since my return I have read all former reports on the river and harbour, from the survey of Mr. Langley Edwards, in 1757, to that of Mr. James Walker, in 1841, also the five Acts of Parliament relative to the harbour, and the evidence taken before the Commissioners in 1839; all of which has been readily furnished to me by Mr. Stead and Lieutenant Ellis, from both of which gentlemen I have derived the greatest assistance in the course of my inquiry.

I am thus particular in stating my authorities, in order to show that, whatever opinions I may offer, though they may be erroneous, have not been formed without ascertaining the facts that appeared to me to bear on the question, nor without hearing what those who are most interested or best qualified had to say on the subject.

River Blyth.

The river Blyth has its chief sources in the parish of Rumburgh, to the north-west, and of Laxfield to the south-west, in the north-eastern part of Suffolk. Receiving in its course six tributary streamlets, it flows in a general easterly direction, chiefly through a narrow diluvial valley, averaging half a mile wide, and falls into the North Sea at Southwold. The outer or sea-reach of the river, which for the last mile of its course now runs nearly straight in a south-east direction, forms the harbour, and communicates with the sea between piers of timber placed at right angles to the general line of coast, and beyond which they project about 100 yards. The width of entrance is 115 feet.

The tract of country drained by the Blyth is of the tertiary formation (provincially termed "Norwich Crag"), and has no eminences of any importance. It may be 50 square miles in extent, and the volume of fresh water carried down by the stream, even in freshes, is insignificant.

The river is navigable at tide time for vessels of about 200 tons as far as Reydon Quay, at 1½ miles from its entrance; then by wherries or barges 4 miles farther up to Bulchamp Lock; and thence again by means of six locks (through which in the course of 4 miles there is an ascent of 27 feet) to the thriving town of Halesworth, one of the chief corn markets of the country.

Southwold Road.

Southwold Road, more familiarly known as Sole Bay, has good anchorage in offshore winds in 5 and 6 fathoms at the distance of half a mile, and 3 fathoms at a quarter of a mile from the coast. The depth then gradually shoalens towards the beach till within 250 yards of the piers, where a ridge called the "Sand Haile," or "Mill's Knoll" (thrown up by the offscour of the beach, or by the stroke of the sea at its first break in heavy easterly gales), extends along parallel to the coast, having on it a depth of only 6 feet. Between this and the shore the water again deepens to 12 and 15 feet, until we approach the "Harbour Shoal," a sandy flat, caused by the meeting of the outset of the river with the coast stream; and on this, as a base, a shingle bar rests, usually in a crescent-like form, but varying in shape and height, according to the prevalent winds.

Tides.

From observations made by the Harbour Surveyor, and also during Mr. Wright's survey, it appears that the *time* of high water, at full and change of the moon, is as follows:—

	H.	M.
At Southwold pier heads . . . . at	10	15
At Reydon Quay (at 1½ miles) . . . . . . at	10	40
At Blythborough Bridge (4 miles from pier) . at	10	50
At Bulchamp Lock (at 5½ miles) . . . . . . at	11	5

or 50 minutes later than at the harbour's mouth.

From similar observations on the tide-scale at the entrance of the harbour (the *zero* of which is said to be on a level with the average low-water springs), we have for *range*—

A good spring tide . .	6½ feet	Average neaps	3½ feet
An equinoctial spring .	9	Average of 80 tides taken during Mr. Wright's survey . . .	5 feet
Greatest range observed .	10		

From a fortnight's observations made by the coast-guard in June, 1834,* and June, 1835 (perhaps the least favourable month of the year), it appears that the

	Feet.	In.		Feet.	In.		Feet.	In.
Greatest range was . .	7	2	and	6	5	giving the mean	6	9½
Least range	4	6	. .	2	10	. . . .	3	8

or a greater range in those two months than at Yarmouth, Corton, Lowestoft, or Kessingland.

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* Philosophical Transactions.—Mr. Whewell on Tides.

Rate of tide.

It has also been found, by careful observations, that the tide at high water reaches the same horizontal level at all places along the river, as far as Bulchamp Lock; and that low water at the harbour's mouth is only 1 foot lower than at the same Lock.

The rate of tide within the harbour averages 2 knots, gradually decreasing up to the first lock. Occasionally, when the channel is much narrowed in its limits by shingle or otherwise near the inner ends of the piers, it is said to run from 3 to 4 knots an hour. In the offing the rate of the tide seldom exceeds 2 knots; the ebb stream setting to the north-east, and the flood to the south-west, and running respectively rather more than half an hour after low and high water by the shore.

As Southwold is a place entirely dependent upon tidal waters for existence as a harbour, the above details of the tides, although rather tedious, seemed absolutely necessary. We may now proceed to consider the past and present state of the port.

No old plans.

We have no proof from actual soundings of the original depth of Southwold Harbour. Greenvile Collins, who, by direction of Charles II., surveyed this coast in 1682, gives no chart of it in his "Coasting Pilot;" but it seems to be admitted on all sides, that at former periods there was a fair depth of water in the harbour. In the plan of Isaac Johnson of Woodbridge, who surveyed the river in 1806, there is, with the exception of the Flats, a depth of from 7 to 8 feet, when reduced to low-water springs. In Mr. Wright's survey in 1840 there is a general depth of 6 feet at least, as far up as Reydon Quay.

So far from documents. On turning to the evidence, we find that, however conflicting that of the old pilots, &c., is (and it is sufficiently so), there are two points on which all are agreed—namely, as to the gradual deterioration of the harbour, and its bad state down to the year 1833; and the great improvements, under the present Harbour Surveyor, by dredging the channel,* by cutting through the "Bellar Shoal," and by straightening the lower course of the river.

They are also unanimous that, in spite of these improvements, the bar is still very bad; and the majority agree in attributing this to the embanking of certain marsh lands in the upper part of the river, whereby a quantity of tidal water has been excluded, and the velocity of the stream materially diminished.

Extent of embankments.

What, then, is the nature and extent of these embankments? On reference to the accompanying plan, it will be seen that the whole area formerly overflowed by the tidal waters of the river Blyth was, at every spring tide, about 2000 acres, exclusive of the Dingle, Westwood, and Dunwich Marshes, about 1200 acres of which are also considerably below the level of a similar tide. By the various embankments (tinted green on the plan), this area of 2000 acres is reduced to 450 acres, the present water surface at high tide; the area, then, from which the tide is excluded amounts to 1550 acres.

Now, it has been shown that the high-water tide at Bulchamp Lock reaches the same horizontal level as at the harbour's mouth; over more than half this area, then, the depth at high water, ordinary springs would exceed 2 feet; in the event of high spring tides it would be 4 feet; and in north-west gales, or equinoctial springs, fully 6 feet. We have thus the means of calculating roughly the quantity of water excluded by these embankments; and, taking this at the lowest estimate—that is, at a common spring tide—it gives us in round numbers 150,000,000 cubic feet of water. Now, about three such tides occur at each spring or 78 a year; from which some notion may be formed of the enormous loss of scouring power sustained in consequence of the embankments in question.

No notice is here taken of the 1200 acres of Dunwich Marshes, nor any allowance made for extreme tides, which would probably more than double this amount, and far more more than double its power; for it must be borne in mind that the injury done by any diminution of the power or head of water which scours a river and removes obstructions, is not simply in proportion to the quantity excluded; it increases in a much greater ratio. Besides the actual exclusion of tidal water, and formation of foreshore common to all embankments, all encroachments on the area of a river are mischievous, from the stilling effects on the wash of the waves for want of space; as this wash helps materially in maintaining a general depth.

Act 46 Geo. III. c. 153.

Such, then, appear to be the nature and extent of the embankments in the river Blyth. Now, by the decision of the Judges, founded upon *Magna Charta*, and all statute law, "all land subject to the flux and reflux of the sea and the soil of all navigable rivers in England belongs to the Crown:"—the above mentioned marshes therefore are Crown Lands.

By the same decision of the Judges, "no length of time can legitimize such encroachments;" nor have they been authorized by any grant of the Crown or by any Act of Parliament: the embankments therefore are illegal.

Their immediate prejudicial effects to navigation are visible in a bad bar and a sluggish stream.

Depth due to tidal water.

Now it may be contended that the improvements in the harbour, or lower part of the river, fully compensate for the tidal water embanked out in the upper part of the Blyth; but even supposing that they did so, which I cannot for a moment admit, why should Southwold, more than any other port, be deprived of the scanty advantages bestowed upon her by nature, and not rather have them jealously guarded with the utmost care, and in addition to them have all the improvements that artificial means, directed by a skilful Harbour Surveyor, can bring to her aid. Had the port, besides the deepening of the lower part of the river, had the advantage of the above-mentioned 150 millions of cubic feet of water scouring to and fro 78 times a-year, who can doubt but that the bar might have been kept down to a moderate height as at Yarmouth, and other ports along the coast. For it must never be forgotten (which is indeed received as an axiom by all engineers), that the depth of water in a port or the lower part of a river is not due to backwater or freshes, but to the amount of tidal water that daily passes to and fro. Compare for a moment the fresh water brought down by the Blyth, with the volume of tidal water that it daily receives even in its now contracted dimensions, and see how utterly insignificant is the stream; how much greater, then, would have been that disproportion, if the whole surface of the 1500 acres now embanked had been permitted through the medium of a well dredged and straightened entrance to be covered at every spring tide.

It does not appear from any documents that I have been furnished with, that the proprietors of the embanked lands along the margin of the river have paid anything towards the improvement of the harbour, but that this expense has been defrayed entirely out of the Southwold port dues; now, who pay these dues? From the papers before me, it seems that they have been chiefly paid by the merchants of Halesworth, who ship their corn and malt, and import their coals, &c. (when the bar will allow them to do so), through this harbour; they, therefore, have a right to claim that no obstruction shall be offered to the free influx of the tide in a river in which they are so deeply interested.

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* It appears by Mr. Stead's letters to the Southwold Commissioners that he had repeatedly urged the necessity of dredging the harbour.

Value of lands.

Of the present value of the reclaimed lands, or of the cost of the embankments, I have no means of judging; but one of the Harbour Commissioners, who proposed a few years ago to reclaim Buss Creek, estimates the probable yearly value of that land at 3*l.* an acre; but if we may assume half this price, (which is most likely much nearer the truth), the 1500 embanked acres would yield upwards of 2000*l.* a-year; and although I think they are most to blame who first permitted these encroachments, still it would seem but reasonable and just to expect those who now derive such a benefit from lands to which, it appears by the before mentioned decision of the judges, they have no legal title, to expend a portion of it for a few years in deepening the bed of the river, in order to compensate in some measure in depth for the extent of surface of which their predecessors have been instrumental in depriving it. But this is a point I leave for their Lordships' decision.

Improvements suggested.

It is the province of an engineer to point out the proper remedy for the damage which has hence arisen to the harbour, but the more obvious mode of proceeding would seem to be—

To deepen the bed of river.

1st. To dredge the river to a uniform depth throughout, and widen it till its channel contains a reservoir for tidal waters equal to that of which it has been deprived. To cut off the sharp angles; but not by any means otherwise to straighten its course, as the bends of a river are advantageous to it in some respects. This deepening of the channel, besides being of advantage to navigation, would greatly benefit the low lands of the country, as it would materially improve their drainage.

To extend the piers.

2nd. To carry out the piers into deep water—say 12 feet at low-water springs; to curve them slightly to the eastward, till the outer ends approach each other to within 80 feet; and to open out to the E.N.E. instead of to the S.E., as at present.*

One evil of the actual piers is their width of entrance; and although 115 feet seems little enough opening for a ship to enter and to allow the tide to fill the estuary above, yet, when we see that the back water, owing to its great reduction, can only keep a channel open of half that width, we must follow in the track pointed out by nature, and diminish accordingly.

By carrying the piers out about 100 yards into deep water, the pier-heads will be in the strength of the coast current; and if we curve them so as to open out in an E.N.E. direction, it will cause the outset of the harbour to harmonize with the ebb stream along the coast, instead of meeting it at right angles, as at present.

Groynes recommended.

And if in addition firm wooden groynes were run out along the coast, at short distances, to the east and west of the piers, it would be a long time before any shingle bar would form sufficient to damage the entrance. That the opening to the E.N.E would cause a quantity of sand and shingle, and swell, from time to time to be washed into the harbour in north easterly gales, I admit, but this is a much less evil than having an impassable bar at its mouth: and Salt Creek would form an admirably sheltered basin for vessels to lie in, free from swell, at little expense for dredging.

Capable of improvement.

In conclusion, I fully agree with Mr. James Walker, and all engineers who have examined it, that although Southwold will never be a very important harbour, and certainly not a "harbour of refuge," it is capable of improvement, which would much increase the trade of Southwold and Halesworth, and the value of all the property of which this harbour ought to be the legitimate and natural outlet.

I am, &c.,
JOHN WASHINGTON, *Captain.*

To the Secretary of the Admiralty.

No. 22.

No. 22.

Opinion of Mr. Rendel, Civil Engineer, on Embankments of Rivers.—(Referred to in Q. 1865.)

Suppose a river to be reduced in its surface by cutting off pools and openings, (but retaining the same amount of land waters,) straightening the banks, thus increasing the velocity, scouring the river of banks of mud:—

I. Will the tide run higher up the river?	It will.
II. If it should do so, will that be from greater velocity of tide? III. Or, from the tide running by a shorter course, it necessarily runs higher up?	To both in a degree:—to the former indirectly, and to the latter directly.
IV. Or, by being confined by the banks, it runs higher up before it can find its level?	Its momentum is increased by the uniformity of its banks and bed; and hence it makes the time of high water earlier in every part of the river above, and rises proportionably to a higher level.
V. Suppose any or all these results: will the effect be advantageous or injurious to a bar at the mouth of the river?	The effect will be advantageous to the bar, by the greater momentum with which the scour of the land and tidal waters is returned on their ebb.
VI. Will the bed of the river be deepened by the process described?	It will, if the soil is of the ordinary kind found in the valleys of large rivers, and it is to the increased depth and the uniformity of current over the whole width of the channel by the removal of banks and side and bottom eddies, that the same rise of tide at the harbour's mouth causes it to flow further up the country, and to rise to a higher level. Depth is no less important to the momentum with which the water ascends and descends than to the convenience of the navigation.

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* A plan showing the probable effect of such a position of the piers has been drawn by Mr. E. K. Calver, Master of Her Majesty's ship *Blazer*, and with a Report embodying his opinion on the case, has been sent to the Southwold Commissioners. A copy of it is in possession of the Tidal Harbours Commission.

No. 23.

Report of an Admiralty Surveyor on the East Coast of England, on the Port of Harwich.

Woolwich, January 19, 1843.

Harwich a port of refuge.

THE port of Harwich, owing to its general depth of water, its extent, the shelter it affords, and its immediate communication with the sea, is one of the most valuable on our eastern shores; and although the rivers Thames and Humber afford shelter by running far up them, yet Harwich, from its easy access by night or by day, in all weathers, and in all states of the tide, is the only harbour of refuge, properly so called, on the East coast of England.

Memorial of mayor.

The memorial of the Mayor and other inhabitants of the borough of Harwich states, that in this harbour, which in easterly gales has given shelter to 500 sail of shipping at once, great changes have taken place within the last 20 years, owing to the falling down and washing away of Beacon Cliff on the western side of the entrance, and the growing out of Landguard Point on the eastern side, whereby the harbour is already much deteriorated, and is daily becoming worse.

To the truth of this statement I can bear the fullest testimony from my own observations during the last two years, and all the evidence I can obtain, goes to show that the sole and immediate cause of the damage in question is, the digging up and carrying away the cement stone from the foot of Beacon Cliff, and Felixstow Ledge.

Loss of Beacon Cliff.

From the unanimous testimony of the older inhabitants of Harwich, it appears that Beacon Cliff (which is chiefly composed of Blue or London clay, with layers of *Septaria* or Cement stone), has fallen away much more rapidly within the last 25 years than it did at any previous time; but not feeling quite satisfied with this evidence, I have procured plans of the town and cliff for the years 1709, 1756, and 1804, and have transferred the high and low water lines for these several periods to the plan of Harwich, completed last year in Her Majesty's ship *Shearwater*. From which it appears that in the first half century less than 40 feet, or not a foot a year, of the cliff was washed away; in the second half century about 80 feet went to sea; while during the last 37 years the sea has advanced in a direct line upon the land not less than 350 feet; and the beach at the foot of the cliff has been so much lowered that the low water line, during this short period, has gained 600 feet upon the shore; thus presenting on the western side a greater surface of water, whereby the scouring effect of the flood and ebb streams in keeping the channel clear is much weakened; a barrier that tended to shoot the ebb tide over against Landguard Point is removed; full 40 acres of ordnance, glebe, and manor land, of excellent pasturage, with tenements and other property, have been swept away, and the harbour deprived of an invaluable breakwater in southerly and south-westerly gales.

Evidence from old plans.

Traffic in cement stone.

Now, the traffic in cement stone began about the year 1812, or 30 years ago, since which period, I am credibly informed, that upwards of a million of tons of this stone have been carried away from the shores in question. This fact, combined with the evidence derived from the plans, seems conclusive as to the cause of the encroachments of the sea upon Beacon Cliff.

Extension of Landguard Point.

But while the sea has gained upon the land on the western side of the harbour, the contrary has taken place on the eastern or Suffolk side, where within the last 30 years Landguard Point has grown out 1,500 feet, thereby blocking up the chief entrance into the harbour; so that where in the year 1804 was a channel seven fathoms deep at low water, is now a shingle beach as many feet above high-water mark.

Felixstow Ledge.

This mischief has been accelerated by carrying away the cement stone from the foot of Felixstow Cliff, about two and a-half miles to the north-eastward, where it formed a rocky projecting ledge which served as a breakwater, for the whole of this shore, from the force of the sea in north-easterly gales. But since this stone has been removed (to an extent of 200,000 tons I am told), a large slice from Felixstow Cliff has gone into the sea, two mortella towers and a small battery, only built in 1808, have been swept away, and the beach of Landguard Point has grown out, as above stated, to the extent of 500 yards, in consequence of which the two lighthouses, erected but a few years since at a great expense, are no longer a safe leading mark into the harbour; on the contrary, they have already caused serious damage to several vessels by running them ashore.

These are great and increasing evils, and demand immediate attention, if the port of Harwich is to be preserved.

Remedy recommended.

It is the province of an engineer to point out the proper remedy to take, but the more obvious measure would seem to be to put an immediate stop to the daily practice of carrying away cement stone from the foot of the cliffs, and to replace by an inexpensive breakwater of rough stone run out about 800 yards, the natural barrier which has been carried away from the foot of Beacon Cliff, whereby the ebb stream will be again directed against Landguard Point, so as to prevent its extension, and the shelter to the outer part of the harbour in northerly and southerly gales will be restored.

Of the large quantity of cement stone that has been carried away from under Beacon Cliff, I am informed that 200,000 tons have been taken by the Board of Ordnance, and applied to Government uses.* If such is the case, perhaps it might not be considered as expecting too much to call upon that Board to protect the cliff from further encroachments, and to replace by groynes, or other artificial means, the natural breakwater that they have been instrumental in causing to crumble into the sea, and thereby most seriously damaging the harbour.

A pile jetty recommended.

Mr. Walker and Mr. Rendel have recommended a pile jetty along the northern face of the town, in which I fully agree; but the interests of navigation require that some care should be bestowed in preserving and improving the present channel into the harbour. Since the deep water entrance by Landguard Point is lost (certainly for some time to come,) the actual channels should be dredged so as to command a depth of 15 feet at low water, or 27 feet at high-water springs; this would be attended with little expense, as the dredgers now on the spot would gladly undertake the work for a bounty of 1*s.* a ton on all the cement stone taken away from the different shoals in the harbour, and there would be no difficulty in pointing where and how this might be done to the greatest advantage.†

Dredging proposed.

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* The Ordnance have had a cement mill at Harwich, since the year 1818, let the greater part of the time for 500*l.* a-year, and now at 300*l.* a-year.

† The Admiralty have since granted 100*l.* for this purpose; besides which the Corporation of the borough of Harwich have liberally expended a similar sum, with which 520 tons of soil were dredged up, 70 tons of this were of cement stone, worth 5*s.* a ton.

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Improvements in surveying.

A small red harbour light would also be required to be placed about 25 yards to the southward of the present low light, to obviate the mischief now of daily occurrence, in consequence of the two lights in one being no longer a safe leading mark to clear Landguard Point. The harbour buoys might also be much more advantageously placed than at present,* and two or three small beacons would be required; but the greatest improvement to the navigation of this part of the coast would be a small floating light near the entrance of the harbour, and a fixed light at the tower of Walton-on-the-Naze.

Increasing trade.

The above recommendations are suggested not only by the increasing trade of the ports of Ipswich, and Manningtree, of which Harwich is the outlet, and by the extent of the Government property in the town, but more especially by the present value of this harbour as affording shelter to the vast body of shipping that daily pass along the east coast of England in winter as well as summer, and the facility with which assistance is rendered from this port to vessels wrecked on the Shipwash to the north-east, and the West Rocks, and Gunfleet Sand to the south-east, perhaps the most dangerous sands in these seas. It is well to bear in mind what this port was during the last war, and what it must again become for another North Sea fleet. It was from Harwich that the Hollesley Bay fleet was always watered by transports; it was here that all vessels, from a frigate downwards, in case of need came for a partial refit at the naval yard still in existence; here not less than 60 ships of war have been built, 15 of which were two-deckers, while the tonnage of the vessels employed in the North Sea Fishery belonging to Harwich, a few years since, was estimated at 3000 tons, employing 500 hardy seamen.

Hollesley Bay, fleet watered here.

North Sea Fishery.

Probable mail station.

These considerations alone would more than justify any small outlay to preserve this port from further damage, but in addition it should be remembered that this may shortly become the packet station for all our mail communications with northern and central Europe, that as soon as the railroad, already open to Colchester, is completed to Harwich, letters dispatched from the General Post-office might be delivered in three hours direct on board the Mail Steam Packet lying waiting alongside the pier,—that passengers could walk on board, and in less than a quarter of an hour be clear out at sea, in all weathers and at all times of tide, and 60 miles ahead, even in fine weather, of those mailed at the same time in London, which would probably make the difference of a whole tide in arriving off Ostend or the Brielle, or other bar harbours, while in north-easterly gales and fogs steamers would often make their passage before those starting from London could get clear of the shoals and currents of the deep gulf which forms the estuary of the Thames: in proof of which 28 steamers, carrying mails, in spite of strict orders to the contrary, have been compelled to put into this port for fuel, or to land their mails, after contending for upwards of 24 hours against strong head-winds, which prevented their making their voyage.

Steamers put in for fuel.

Under these points of view, then, but chiefly as the Packet Station for all northern and central Europe, (thereby avoiding the less expeditious and less secure transit through France,) the preservation of this port appears to be of national importance.

JOHN WASHINGTON,
Captain of Her Majesty's Ship "Shearwater."

To the Secretary of the Admiralty.

No. 24.

No. 24.

Report of an Admiralty Surveyor on the East Coast of England on the Port of Whitby; with some Notes on Scarborough, Filey Bay, and Bridlington.

H. M. S. Blazer, Whitby Road,
October 12, 1844.

SIR,

IN compliance with your general instructions, to lose no opportunity of examining and reporting upon every port which in the course of our survey we may chance to visit, I beg to acquaint you that, having learnt at Scarborough that Mr. James Walker, C.E., was to be at Whitby this morning, we weighed from that Bay at daylight and ran down here, where we are at anchor in the Road, in 9 fathoms water, good holding ground, about half a mile from the pier end. The outer point of the Whitby Scar bearing S.E., the northern extreme of land N.N.W., and thus it affords good shelter to the coasting trade in all southerly and westerly gales.

On landing, I met Mr. Walker; his assistant, Mr. Comrie, who had been engaged for some time in making a plan of the harbour and the entrance; Lieutenant Brittain, R.N., of the Coast Guard, who has been here 10 years, and appears a seamanlike, intelligent officer, and well acquainted with the port; Mr. F. Pickernell, the resident engineer; and Mr. Clarke, the harbour-master; and walked with them round the piers, and examined the harbour.

A stranger's first impression, on setting his foot on the west pier, must be that of admiration at its bold dimensions, both in width and length, and its beautiful structure of the well-known Whitby stone. The picturesque valley of the Esk,—the defined outline of the pier and lighthouse,—and the ruins of the far-famed Abbey on the cliff above,—form a striking scene.

On turning to the harbour, a sailor is struck by the contrast: with the exception of the small stream of the Esk, the harbour is dry at low water, and its entrance and sides encumbered by sands; even the light boat in which I landed was obliged to push outside the piers to remain afloat, and the bar dries 4 feet at low-water springs.

Having the advantage of a tide ranging 15½ feet on average springs, 17 feet on good springs, and 20 feet on equinoctial springs, or in a N.W. gale, there does not, at first sight, seem sufficient reason for the bad state of the Bar and this accumulation of sand; but a little inquiry as to the state of the upper part of the river, and an attentive consideration of the relative length and position of the piers, and the width of entrance, will, I think, account for much of the evil.

The latter, however, are rather engineering questions, into which I do not feel qualified to enter; but I may state that it is the opinion of the officer of the coast guard, who has resided 10 years on the spot, has watched vessels entering in all weathers, and seen many wrecked on the Scar behind the east pier—

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* These alterations have since been made by the Trinity Board, with the invaluable addition of a light vessel placed near the entrance of the harbour.

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1st. That the width of entrance (300 feet) is one-third too great.

2nd. That the east pier should be carried out to cover the Scar to the same length as the present west pier.

3rd. That the piers, instead of running out in a N.N.E direction, as at present, should have been carried out in a north or N. b W. direction, fair with the lower reach of the river. This, too, would have given greater shelter in N.E. gales—the worst on this coast—and have prevented much of the swell that tumbles into the harbour.

Lastly. That the billet head of the west pier should have been a fiddle head (to use a sailor's phrase) or turned the other way.

As far as a short visit will enable me to judge, I confess that I agree with these remarks:—1st. If it were quite certain that ample room would be left for the entrance of the tidal water, so as completely to fill the channel above, I would, under the peculiar circumstances of the case venture to recommend the narrowing the entrance even to 180 feet.

2nd. This narrowing would, I think, be best effected by extending the east pier in a north, or perhaps in a N. ½ E. direction, to the same length as the west pier; and, with every deference to engineers, I should be disposed, in so doing, to curve it very slightly, convexing to seaward; for, as I stood on the pier at low water and watched the puny efforts of the river stream struggling to make its way out, I observed that it naturally curved, as all rivers do, and formed the deepest channel in the bight: this curve would also have the advantage of directing the outset of the ebb to harmonize better (at least for four hours) with the ebb stream along the coast, which here sets to the north-west, instead of meeting it nearly at right angles, as at present.

3rd. The Bar, or rather its nucleus, is formed by a part of the Scar composed of alum shale rock, and in low spring tides the water falls out 2 feet below its surface; so that, however the freshes may scour away the sand, this Scar remains as a weir across the harbour, ready to catch and retain every particle of sand thrown in by the waves. Besides the additional evil of risking a ship's breaking her back upon it in the event of striking, if running in in case of great need before a heavy sea. This should be immediately remedied. The alum shale is not a hard rock, and blasting under water has lately become so common a process, that there is no excuse for its being allowed to remain—especially as I understand five vessels have been wrecked on it during the last few years.

The short time I had at command would not allow me to walk along the upper part of the banks of the river; but in reply to my inquiries, I learnt that there are several obstructions to the free flow of the tide, which are incompatible with a good state of the harbour. Such as a ford across the river; a new narrow straight channel in part substituted for the former wider and circuitous one, (said, I think, to have been made by a railway company); and an addition to a quay lately erected projecting into the river some distance below high-water mark; but the great evil is, a dam or weir of a mill (the name of which I forget) across the river, which completely stops the flow of the tide upwards in its natural channel.

Besides these grievances, it was pointed out to me that the back of the west pier is the usual place of deposit for the rubbish of the town, which at the next high tide is washed down and carried into the harbour on the flood; while, throwing ballast over in the harbour is considered so venial an offence, that three men brought before the magistrate for doing so only the Saturday preceding my visit, were not fined, but only reprimanded.

Need we wonder at the encumbered state of the harbour and the dry bar.

Yet Whitby is a port of much consequence. Here are 14 building slips and 7 repairing docks, employing 300 shipwrights; 50,000 tons of shipping belong to the port; 2000 arrivals and sailings take place annually; its seafaring population consists of 2500; its coast fisheries employ 244 boats, and 750 men; quarries of alum rock, whinstone, and freestone, are in the immediate neighbourhood, and the Egton, Aislaby, and Cragwell stone is in request all along the coast for building.

The revenue of the port, too, is 3600*l.* a-year, partly derived either from a passing toll on shipping, or a tax on coal, specially imposed "for the improvement of the harbour."

Here are 65 Commissioners of the port, noblemen and gentlemen of the first station in the county, including among them the representative of the town, himself a sailor and shipowner, and one of the most intelligent and experienced members of the Trinity Corporation. I can only imagine, therefore, that the real state of the case is not laid before them. Knowing, as I do full well, the vital importance of a good harbour on this part of the coast, too notorious for its shipwrecks, I would venture to entreat them to see and examine themselves into the real state of the harbour, to take the opinion of one of our most eminent engineers, and to spare no expense till every obstacle is removed that impedes the free flow of the tide, and by dredging and other means to encourage it to flow up the river Esk as far as they can, so as to command all the natural backwater possible. Something was said, if I remember right, by the engineer, about damming up water to sluice out over the bar, but having seen in nearly every case in which it has been tried the utter inefficiency of such artificial backwater, I would trust to the free use of the dredge to form a reservoir in the natural bed of the river, which plan has the advantage of securing the unceasing scour of the tide twice a day, or 704 times a year; and this scour joined to the winter freshes, and the removal of the Scar, would, I doubt not, effectually exonerate Whitby from the reproach of being a 'bar-harbour.'

During the two months we have employed on this coast, on the surveys of Scarborough and Filey Bays, which have been completed by Mr. E. K. Calver, master and assistant-surveyor of this ship, we have repeatedly run down here, and each time I have been more impressed with the great want of a large buoy or beacon at the extreme end of Whitby Scar,* which is a very dangerous ledge of rocks, covered, except at very low tides, extending more than half a mile off shore with deep water close to; the same want, although perhaps not to so great a degree, is experienced at the end of Filey Brig and Flamborough Head Ledge. I have lying by me a list of 14 vessels wrecked on the Brig, many of which doubtless might have been warned off by a buoy or beacon at its end. On Flamborough Ledge, you may yourself remember we saw two light colliers at once; and it was here that the Driver, war-steamer, ran ashore and was much damaged.

Scarborough Harbour might be much improved by the west pier being carried more to the westward, and placed so as to shoot the sand and eddy tide off, past the eastern pier-head, instead of leading it into the harbour as at present. The harbour trustees are crippled in their exertions from the

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* Placed in June, 1845.—[ED.]

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want of funds, the corporation claiming a part of the dues, they have, however, recently evinced much public spirit in clearing out their eastern harbour, and in erecting a self registering tide gauge at the pier end. Its record is to be accompanied by a barometric register, and a journal of the winds and weather, to be kept in the lighthouse by the intelligent harbour-master; this is the first instance on this part of the coast, of proper attention to the phenomena of the tides, on which most of our harbours are dependent for their very existence, and we trust that the good example may be shortly followed at other ports in the neighbourhood, and especially at Whitby and Bridlington Quay.

Filey Bay offers fair shelter for a few vessels in north easterly gales, if they can anchor well up under the lee of the Brig which is a remarkable natural breakwater running off half a mile in a south-eastern direction from the shore. The rocks are of calcareous grit, stratified and abounding in fossils; the strata dip about 12° to the south; a more inviting foundation for a breakwater can hardly be imagined, but unless it were continued round so as to form shelter from east and south-east, it would be of little use. Stone is abundant, and to be had for the carriage, and when Government shall be at liberty to attend to the wants of sailors on this part of the coast, which sooner or later must be done, Filey Bay will deserve attentive consideration.

The Spital, as it is called, a small ledge which projects from the Brig in a south direction, appears to have been the foundation of an artificial pier; it is formed of rubble stones of about 2 cwt. each, and may have been intended for the shelter of fishing boats, but never finished, there is no record or tradition of its construction.

Bridlington Bay is the only good shelter in north-easterly gales on this coast, and in a continuance of such winds, 200 vessels may be seen lying here under the shelter of the Smithick Sand, which helps materially to break the sea, and would form an admirable foundation for a breakwater, and so make this bay a harbour of refuge. It was from strong evidence of the value of this bay, and of the utility that would result from an enlarged inner harbour, with convenient access for getting off provisions and water for wind-bound ships, that Parliament granted in 1837, a passing toll to be levied for the enlargement and improvement of the harbour by building a new south pier; under this Act a sum of upwards of 18,000*l.* has been raised, which appears to have been expended in a north pier, which is a fine piece of masonry, but is little or no shelter to the harbour from southerly gales—in September 1843, I found the plan for the south pier had only just been decided on; during the last month I have seen the works in progress, and it is said that they are to be completed in Sept., 1846; the pier is to be 330 yards long by 17 yards wide, the facing to be of Whitby stone, to be filled in with square masses of hard chalk; and the entrance of the harbour to be deepened to 18½ feet below the high water of ordinary spring tides.

I trust that special care will be taken to see that the contract is strictly fulfilled; yet blocks of chalk are doubtful materials to be employed as a core to a pier exposed to the heavy sea, which at times breaks in here in a southerly gale, and we know that at Ramsgate Pier, under the lighthouse it washed out, and was obliged to be replaced by stone. Care will be requisite too, to see that the foundations are laid deep enough, as the sand is very light, and it may so happen that the very erection may cause a scour along its outer end that would undermine it in a short time.

The landing place at the north pier is so far up the harbour, that boats cannot get near it at low water; and with any sea the harbour is unapproachable at that time, except by the Yorkshire cobbles, which are well adapted for taking the beach. I found no tide scale here, and no register of the tides kept; the harbour lights seemed to be but a poor affair; the harbour itself encumbered with sand, and I must add that there appeared many symptoms of the want of an efficient harbour-master.

As both Bridlington and Whitby levy public tolls on shipping, or on coals, it would seem but right that Government or Parliament should have some control over the manner in which such funds are expended.

We sail this afternoon for Shields to replenish our coals.

I am, &c.,
JOHN WASHINGTON, *Captain.*

To Capt. Beaufort, R.N., F.R.S.
Corr. Inst. France. Hydrographer.

No. 25.

No. 25.

Report of Mr. James Walker, C. E., on Whitby Harbour.

MY LORD AND GENTLEMEN, *Great George-street, 4th January*, 1845.

Instructions.

THE substance of the resolution of your meeting of the 3rd April, communicated to me by the Marquis of Normanby, is,

That I survey the piers and harbour of Whitby, and report my opinion on the best way of extending and improving their capabilities and approaches.

Surveys.

Having in July last despatched my assistant, Mr. Drane, to measure and plan the entrance and the harbour, and to make observations on the river and tides, I visited Whitby in August, and made such survey as the time and state of the tides permitted. I also took the opinion of pilots and others, and afterwards attended a meeting at which Mr. Fishburn presided.

Circumstances obliging Mr. Drane to leave Whitby, I sent down Mr. Comrie, a surveyor of great experience, early in October, to complete the necessary surveys, plans, and sections; and during the same month I again visited Whitby, continued my survey, and took additional evidence respecting the harbour and river. After my survey a meeting of the trustees was held, at which the Marquis of Normanby presided, when I was interrogated on various points, and gave my opinion generally, so far as I then had the means of forming one.

I consider that I was thus in possession of the means for judging of the defects of the harbour, and reporting the remedies that appear to me best suited for lessening or removing them; and I proceeded to give these subjects my best consideration.

Having completed the draft of my plan and report, I went to Whitby again in December, when I explained my ideas generally to Mr. Pickernell, your engineer, and Mr. Clark, your harbour-master, and having discussed the various practical matters with them, I believe I may say that there is little or rather no difference of opinion between us in any matter of importance.

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Previous to reporting my opinion, it will be proper to give a general description of the present state of the harbour and its entrance; for although these must be familiar to most of you, my report may have to be submitted to others, who have little or no personal acquaintance with Whitby.

Description. Whitby is situated in latitude 54° 30′ north, and longitude 30′ west, 26 statute miles south-east of the river Tees, and 17 miles north of Scarborough, the two nearest harbours. The River Esk, of which Whitby Harbour may be considered the "mouth," is a very small stream in times of drought, but forming the drain of a hilly country which extends 16 miles into the interior, it sends down considerable floods during the rainy season. The tide which flows up the channel of the Esk to the tail of Ruswarp Mill, a length of two miles and a-half, and fills the small bay or estuary opposite to the town; contributes in its return to assist the land floods in carrying out the sand, and in forming the entrance and the harbour. Of the two forces the land water is, as will be seen afterwards, by far the more important. The scour of the tidal water, taken separately, is of little or no account; its only value in this respect is as an auxiliary to the land floods.

To these operations of nature, the formation of the town and of the harbour of Whitby is no doubt owing; but they have been materially aided by the artificial works done at various times, particularly by the erection of the piers, which have guided and confined the land and tidal water out to low water at sea, and (to an extent) protected the shipping within them.

The bearing of the entrance of the harbour from the turning or swing bridge which divides the outer from the inner harbour (a length of half a mile) is north-north-east, one-third east by compass, or nearly *true* north. In this length there is a considerable curvature to the westward, and several projections, as shown upon the plan, which tend to break and reduce the range of seas in the harbour.

Tides. At the harbour's mouth the rise of tide is as follows: upon zero* of the gauge affixed to the quay below the bridge (which is one foot above the level of low water of spring tide)—

	ft.	in.
Average of neap tides upon the gauge	11	0
Or from low water	12	0
Average of spring tides upon the gauge	16	0
Or from low water	17	0
Making therefore the depth of water upon the gauge at the average of spring and neap tides	13	6
Equinoctial spring tides ebb two feet under the average level of spring tides, and rise two feet higher, making a total flow or lift of .	21	0

On the days of full and change of the moon it is high water at half-past three o'clock. The best tide is the second day after, say at five o'clock. The tide is, as in most other places, influenced by the winds; north-west causing the best flow, and south-east the worst.

Outside the harbour is a flat bed of alum rock, called "Whitby Rock," and the Scar, extending upwards of half a nautic mile from the pier head. The current of tide is what is commonly known as "tide and half tide," that is, it runs to the south for two hours and a-half after it is high water at the harbour's mouth, and to the north for two hours and a-half after low water at the harbour's mouth, the greatest velocity being two miles and a-half per hour. Inside, or near the harbour's mouth, the first of the flood tide is directly into the harbour, the Scar being so high as to prevent a current along the coast; but when these are covered it runs also to the eastward, towards Saltwick Nab, and continues in that direction until about an hour after high water, the greatest velocity being about half flood.

Rocks. The "Scar" and "Whitby Rock" before referred to covers the whole area to the eastward of a line drawn *true* north, from the middle of the entrance; close to the piers the rock shows a little above low water, and the outer end of the east pier is founded on it. Immediately outside the entrance it falls in 100 yards to 6 feet under low water, and in the next half mile does not deepen to more than 10 feet under low water. A portion also of the rock near its outer end, which lies north-east of the harbour, at half a mile distance, is dry at low water of low spring tides. Between the rocks and the shore is a space, over which the depth is from one to two feet greater than over the average of the rock outside it, and the surface is more regular. In fine weather this forms a passage for small vessels, called the Sledway. On the west and north sides of the rock there is a sudden drop along its edge to nearly twice the depth upon it, which depth still increases to the westward, where the bottom is clay, forming the roadstead with nine fathom water, at less than a quarter of a mile from the west edge of the Scar.

It is evident that these rocks must render the harbour unapproachable for vessels of burthen from any point east of north-north-east, except at the high water of spring tides; but this disadvantage is, to a degree, counterbalanced by their breaking the heavy seas, with winds to the eastward of north-east, so that the harbour is partially protected except from winds between north-west by north and north-east, seven points only, to which it is quite open.

Piers and entrance. As the direction of the west pier is north-east, as much advantage has been taken of the rocks to protect the entrance as could be taken, consistently with the facility of ships entering. The north-north-east gales just clear them, and at the same time have a fair run between the piers: hence the greatest range into the harbour may be expected, and I believe is with north-north-east gales. With all winds to the eastward of north-east, although there may then be greater surf, there will be less *swell* and *range*. Again, whenever the wind gets to the westward of north-west by north, the seas (as may be inferred from inspecting the plan) get into a direction more along the land or across the entrance, and therefore tend less to cause *swell* or *run* in the harbour; but north-west winds are attended with another and more permanent evil, viz., agitating the sand upon the shore to the westward, and bringing it round the west pier into the harbour's mouth, there forming the bar.

These are therefore the two principal defects of Whitby Harbour; viz., the great range of sea into it during gales between north-west by north and north-east, and the collection of sand producing a bar between the pier heads with westerly winds.

The present formation of the entrance, which I am about to describe, does not appear the best for counteracting these evils.

The width between the piers is 280 feet at the bottom, and 300 feet at the top of the walls. The effect of so great a width is to admit the seas into the harbour and to add to the swell.

The west pier, in respect to its length and breadth, and as an engineering work, is one of the finest in the kingdom; the last addition to its length was about 40 years since, by Mr. Pickernell, grandfather of your present engineer. Its direction is, as has been stated, north-east, finishing with a bold circular head or funnel-mouth, the effect of which shape is increased by the head of the east pier being *retired*, as has been described. This form tends farther to admit the swell, which, after getting round the head, runs up the smooth inside surface of the north pier with great power, breaks over the Scotch Head with violence, and ranges round the end of it, up the harbour. and even through the bridge (although the four openings under it are altogether only 117 feet), to such an extent as to cause considerable swell in the inner harbour.

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* Zero upon the gauge is 22 feet under the ground-floor of the public Subscription Baths.

The direction of the east pier is north north-west, forming an angle 67° 30′ with the west pier, which projects about 100 yards beyond the east pier. From this inequality in the length of the two piers arises another evil, viz., a difficulty to ships entering the harbour, through the eddy, between the termination of the west and that of the east pier, this space being out of the way of the fair *run* of flood tide. A ship caught in this eddy with a scant wind is apt to lose both her "way" and her "steerage" before she gets within the east pier, so that the action of the tide pressing her starboard quarter to the eastward, while the eddy is turning the larboard bow in the opposite direction, her *head* is brought round to the westward; she then drifts bodily to the eastward, and is in danger of either striking the east pier or of going upon the rocks behind it.

Bar.

During my two first visits to Whitby, the weather was fine, and the bar, owing to the long drought, was bad. Taking zero upon the tide-gauge, as being the low water, the sand was from three to four feet above this level for the western half of the width between the piers; the remainder was nearly dry at low water. The spit of sand extended out 100 yards in an easterly direction before it reached low water.

In October, the fresh-water course near the pier heads was more tortuous. From the "Scotch Head" it shot off to the eastward, until nearing the east pier, when it crossed back to the west pier, and then turned again to the eastward, leaving a shorter spit against the west pier. In the level of the sand, or facility for ships entering, there was but little difference. I name these particulars to show the present uncertainty of the channel and its small depth, when it has been long without a land-fresh to scour it. It is evident that there was, at the above time, only 12 feet at spring and 8 feet at neap tides, excepting in the narrow and shifting fresh-water channel. A good river-flood would, it was stated, increase the velocity of the outgoing current near the entrance, from half a mile (its then speed) to upwards of three miles per hour, and would clear the sand down to the rock, giving 3 to 4 feet additional depth, or from 15 to 16 feet at spring tides, and from 12 to 13 feet at neap tides, which was the case when I saw it in December. This was partly owing to a late fresh in the river, but still more to the seas during six weeks of east winds, driving the sand up towards and round the "Scotch Head," where it was heaped up to a considerable height.

A ship drawing about 15 feet 6 inches got into the harbour about four years since, but this is a rare case; and it will be seen by the above figures that all circumstances had then conspired to place the entrance in the best condition.

Advantages as a Harbour of Refuge.

Notwithstanding these disadvantages, Whitby has occasionally been most useful as a Harbour of Refuge, particularly during north-west gales. I was informed of one case in which 75 ships, and of another in which 60 ships had entered it for refuge in one tide. A considerable part of these would, it was supposed, have gone ashore had they not got into the harbour. Mr. Aaron Chapman, the present representative of Whitby in Parliament, is a native of the town, and formerly commanded ships upon this coast. Thus, and from having since frequently surveyed the coast as an Elder Brother of the Corporation of Trinity House, he is well acquainted with the port. He states, in his evidence before the Shipwreck Committee, the public importance of the harbour; in proof of which he names that he has seen from 50 to 100 vessels go out in one tide, and that he saw on one occasion 70 to 80 sail driven in by privateers.

These cases do not alter the facts as to the depth, but they prove the truth of the saying that "Any port in a storm;" and they show the importance, upon public grounds, of improving and preserving a harbour which is, from its position, a port of refuge for life and property, though by no means a perfect one.

Defects.

I now proceed to state some of the interior matters to which my attention was directed, as affecting the harbour and its entrance.

Ruswarp Weir.

The dam or weir that crosses the river at Ruswarp Mill is a complete *stop* to the flow of the tide, as it is only in very extreme cases that it reaches the top of the weir. As a good spring tide rises four feet below the weir, the tide must have flowed some distance higher up the Esk, before the mill was built, than it does now; and, if the weir were removed, the channel above it would gradually deepen, and the tide flow up as before. On the other hand, the river above the mill is narrow, with rising ground on each side; and when the land-freshes are coming down the tide is prevented from going up. Such an erection as this weir, although proposed by the owner of the soil and the lord of the manor (which Colonel Cholmley, the proprietor of the mill, is), would be objected to now, every encroachment within high-water mark, that is injurious to the harbour, being unlawful unless made by Act of Parliament; but, as the mill and the weir have stood as they are for 92 years, and are valuable, the removal, without Colonel Cholmley's consent, is I presume out of the question.

Encroachments.

Other encroachments upon the tideway are more recent. Some of them can, I trust, be removed; or, if this cannot be, their increase may be prevented.

By the Whitby and Pickering Railway Act, a new straight channel was substituted for the old circular course of the river, about a mile above the town, to enable a straight line of railway to be made. This was proper, for the railway is a valuable addition to the town; but the new course being narrower at high water, as well as shorter than the old, the tidal receptacle has been excluded from the old channel by means of a dam. This exclusion does not appear to me at all necessary for the railway, while its tendency is injurious to the harbour; and, unless there is some stronger objection to the removal of the dam than I have discovered, I think it ought to be removed now, and the water again admitted to ebb and flow with the tide, by which 20,000 to 30,000 additional cubic yards of water would pass in and out of the harbour at each spring tide.

About half a mile below Ruswarp there is a ford across the river, made, as I was informed, under the Railway Act; as it is broken through by the current, so as to be useless, I hope there is no objection to its entire removal.

A little higher up the river is a natural obstruction, by which the water is kept up. As this, and whatever tends to prevent the free flow and ebb of the tide, is injurious to the harbour, a jealous care for its preservation would be shown by attention to what may, taken separately, appear almost trifling.

Ballast.

Another and greater evil is, that the sides of the river and of the harbour within high-water mark are used as the place of deposit for the ballast of ships and the rubbish of the town. Only the week before my October survey some offenders in this respect had been charged before the magistrates with throwing chalk, rubbish, and gravel upon the east shore of the river, opposite the "Batts," a mile above the town. The quantity upon the bank appeared to be considerable when I saw it, although a portion of it had been washed down into the stream, and was still visible. The case was proved, but the party let off on paying the costs of the information. Some years since, to throw the ballast within the high-water line was said to be the usual mode of disposing of it. At the present time a wharf is being formed for the Railway Company, between the present quay and Barker's quay, where there was formerly a considerable depth of water; I did not ascertain that permission had been granted for this. Now, although the formation of wharfs is useful for trade, yet I think that such an encroachment ought not to be made without a regular application, and that the permission, if granted, ought to be coupled with an obligation on the party to fill up behind his wharf with material taken from the river *between high and low water mark*, by which a double good would be effected, through the formation of wharfage and the deepening of the harbour, instead of using the ballast of ships for the purpose of backing. As the railway wharf required a channel up to it, this has been made, not at, I believe, the expense of the Company, but of the Commissioners, the material that was excavated being carried out to sea, in place of being applied to back the wharf.

It must be apparent that these gradual encroachments, although small in each month or year, must, in the course of time, not only reduce the depth of the harbour, but also to lessen the contents of the basin. And it is to be particularly observed that the scouring effect upon the channel, which depends mainly upon the *velocity* of the current, is lessened in a more rapid proportion than the quantity is. As there were no correct measurements by which to compare the present with former depths, I directed Mr. Drane and Mr. Comrie to take a number of cross sections of the river, from the entrance of the harbour up to the mill, to assist me in computing the area and quantity of backwater. A copy of these sections accompanies this Report. They are numbered from 1 to 36, and their place marked by dotted lines and corresponding numbers on the Plan A. These, with the correct plan I recommended, and which Mr. Pickernell has undertaken to make from a new survey, cannot fail to be very useful, if applied, to enable you to preserve and improve the harbour; and as the trade and value of property in Whitby depends so much upon the state of the harbour, no one having an interest in the town can be indifferent to the question. After the plan is finished, the limits of the harbour should be periodically surveyed, compared with the plan and sections, and the differences regularly reported on by your engineer.

As a means of preventing the evil I have just referred to, some ready and well-defined way should be taken of disposing of the ballast, which there is not at present. It might be landed and drawn up by engine power, as in the Tyne, or carted and shot over the east cliff, or put into boats with false bottoms, carried out to sea, and dropped to the eastward of the harbour.

The question is, which is the cheapest? The result of a calculation made by me, from premises furnished by Mr. Pickernell, was, that the disposal of ballast in the present injurious way costs more than if it were boated out to sea; if so, the compulsion to take it out would be no hardship upon any one. I strongly recommend that Mr. Pickernell be requested to well consider the subject, and report his opinion; this done, and the means recommended, any attempt to commit a nuisance in the harbour should be so noticed as to make it an example and warning to others. It is quite evident that if the harbour, even in its present state, is to be preserved, the ballast thrown into it must be taken out again, and thus there are two expenses, one of which would be rendered unnecessary if the proper course were adopted at first.

Rubbish. Another regular and almost authorized (at least not objected to) mode of disposing of the town rubbish is into the sea, on the west side of the battery, behind the west pier, whence it is washed down by the seas in north-west winds, and brought to and round the end of the pier into the harbour with the flood tide. The marks of this were visible upon the shore when I was at Whitby: it ought to be prevented; and when Mr. Pickemell shall have determined the place for it on the east side of the harbour, the west side may be effectually closed; but to attempt this without offering a substitute would be almost in vain.

Proposed improvements. I come now to state what appear to me the most certain means of improving the harbour, and to be essential for that important object.

They consist chiefly of—

1st. An improvement in the piers, to facilitate the entrance of ships into the harbour, and to lessen the swell or run within it.

2nd. Forming the inner harbour into an occasional back-water, for the removal of the bar.

Piers. First, as to the piers:—

Having stated that I consider the unequal length of the piers to be the principal cause of the danger and difficulty of entering the harbour, and the great width, with the formation of the end of the west pier, to be the causes of the heavy seas that enter it, the remedies that naturally present themselves are to extend the east pier as far out as the west pier, in reference to the line of coast and set of tide, and to give this additional length such a direction as at the same time to narrow the entrance; also to give the end of the west pier a shape which shall be less inviting for the seas to enter the harbour than the present funnel shape.

I beg now to refer you to plan B, which shows (from Mr. Comrie's survey), on a larger scale, the part of the river from the entrance of the harbour up to and including the bridge.

It will be seen that I have proposed an addition to the east pier, in a direction north-north-east quarter north, for a length of 220 feet, when there is a return of 15 feet to the westward, and the line is then bent a few degrees to the east of north-north-east for a length of 20 yards, this forming one side of the *throat of the entrance*; it is then rounded off with a radius of 30 feet to a sea face or front, square with its side, and by an addition to the present circular end of the west pier, the west, or opposite site of this "throat," is formed so as to correspond with, and be parallel to, the east side, giving a width of entrance of 150 feet at bottom, and 170 feet at top, (the average width being 160 feet,) and the west pier being rounded off to the same radius as the east. This general confirmation will be better understood from the plan.

I have been particular in stating the bearings and dimensions, that a correct opinion of my proposal may be formed by your harbour-master, and other practical men. My opinion is, that while the entrance will be sufficiently wide, the harbour will be rendered comparatively quiet, and the facility of entrance much increased; that there will be less disposition to eddy, and as its consequence, less deposition of sand; and that what sand does collect will have a better chance of being carried out clear of the heads by the outward current. Also that the extension of the east pier will prevent the sand from being driven into the harbour during easterly gales.

I am not aware that more can be done for the entrance without extending both heads out to sea, the cost of which would be very great.

Back-water.

If, however, the entrance were as perfect as art and science (without limit to expense) could make it, the dependence upon land floods for clearing away the accumulation of sand will always make it, not only a bar harbour, but an uncertain bar harbour, good after rains, bad after continued dry weather. For a harbour of importance for trade, and occasionally for refuge, this certainly is a bad character.

Having given this subject my attentive consideration, I think the most effectual remedy is, to place in the contracted part of the harbour, close below the bridge, a pair of wide gates in line with the bridge, opening for the passage of ships, and sluice gates on each side, so that by shutting all the gates at high water, when the bar is bad, and thus penning up the water in the inner harbour until nearly the time of low water, the sluices may then be opened, and the contents discharged through the outer harbour and upon the bar. As in ordinary spring tides a head of 14 feet over an area of 40 acres would be penned up to form a back-water, the power to clear the outer harbour and entrance would be so great as, I think, effectually to remove all sand from between the piers down to the rock, and even *below* the present level of the rock, should it be thought desirable to excavate it. The position of the gates and sluices here referred to, is shown upon plan B, to which I request your attention. If the quantity were small, and the effect to be produced by the *velocity alone* of the water issuing from the sluices, the distance of the bridge to the bar being half a mile would be an objection; but I consider the effect in this case to be more nearly represented by the current of a river which is dependent for its effects upon its quantity, and upon the slope of its surface. If the quantity passing down the channel from the sluices be as *great* as that of the river Esk in a flood, the effect of the back-water in the same time will be similar, and the whole width from the sluices downwards as effectually scoured by it.* If a back-water is to be formed at all, this is, I think, the best mode of making it; and I do not anticipate any difference of opinion on this point by Mr. Pickernell, as he has now given it his matured consideration. It would be quite impossible to collect even a tenth of this quantity in the triangular space between the head of the east pier, and the Herring-house, (Colliers' Hope,) while the walls for enclosing the space would render the penning of this smaller quantity more expensive than forming a pen at the bridge, where scarcely any walling would be required. Again, the enclosing so considerable a portion of Colliers' Hope might be objected to as confining the area over which the seas are spread, and partly expended after entering between the piers.

As the width of the *gates* and extent of *water-way*, by the plan, would be greater than under the bridge, the only inconvenience likely to be felt by the plan proposed by me, would be during the erection of the necessary apron and works.

Estimate.

I estimate the stonework of the piers, as described and recommended, at 30,000*l.*

The cost of the sluices and gates may be 15,000*l.*; but it is proper to state, that this last sum is assumed from the magnitude of the work, and my general experience. To estimate the cost correctly would require detailed drawings, which I have not prepared.

If, however, the whole of the works, including contingencies, be taken at 50,000*l.*, this sum ought not, I think, to be considered great, in comparison with the public and private advantages that would result. And when the ports near you are being improved and enlarged, Whitby cannot be expected to maintain its trade and comparative importance, if it be allowed to remain subject to its present disadvantages.

I was prepared with a recommendation for lessening the present inconvenient swell higher up the harbour by a work at the Scotch Head, but as I think it probable that the alteration of the piers will sufficiently effect this object, I strongly recommend that your attention and resources be, in the first place, confined to the measures I have described.

I have the honour to be,
My Lord and Gentlemen,
Your obedient Servant,

JAMES WALKER.

P.S.—My surveyors and myself have to acknowledge having had every assistance and information from Mr. Pickernell and Mr. Clarke, which it would be remiss not to notice with thanks.

No. 26.

STATE of the RIVER THAMES in the Years under mentioned, from Evidence before the House of Commons in the Years 1732 and 1805.

At Low Tides.	1680	1732	1805
	Feet.	Feet.	Feet.
Abreast the Custom House . .	3 to 4	11 to 12	12
Hermitage, St. Katherine's . .	Almost dry	11 to 12	12 to 14
Wapping to New Crane . . .	,,	13	12 to 14
New Crane to Bell Wharf . .	4 to 5	15	16
King Edward's Stairs	Almost dry	13	15
Queen's Stairs	3	13	15
Oliphant Stairs	5 to 6	13	16
Church Hole to Hanover Stairs .	Almost dry	7	15 to 17
King's Mills	,,	12	17 to 19

540,000 tons of ballast were raised from Barking Shelf from August, 1819, to April, 1822, previous to which it was almost dry, but the river is now navigable. It appears that no ballast had been raised from the bed of the river Thames, nor any ships been moored from London Bridge to Limehouse, that the depths of water would have been less by 12 feet than they now are.

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* The sluices, as shown upon the drawing, are calculated to discharge while the head continues a greater quantity than the land-flood of the river.

APPENDIX.

No. 27.

No. 27.

Messrs. Stevenson's Report on the Improvement of the River Lune.

In the month of March, 1838, we received instructions from the Commissioners of St. George's Quay to make a survey of the river Lune from Glasson Dock to Lancaster, and to report on the best means of improving its navigation.

Agreeably to these instructions we have surveyed the river, and obtained sufficient data to enable them to submit the following report and plan to the consideration of the Commissioners as that which they think best adapted for effecting the improvement of the navigation, which is justly considered an object of the highest importance, as it tends directly to advance the prosperity of Lancaster, and in time to exert a beneficial influence on the interests of a large portion of the inhabitants of one of the most populous counties in England.

Before entering on the subject of the proposed improvement we beg leave to lay before the Commissioners the data which we have obtained, and on which the suggestions in the following Report are framed; and for this purpose we refer them to the accompanying plan and section.

The plan extends from Lancaster to Glasson, and shows the high-water line and banks, or margin of the rivers, together with the low-water channel and sand banks. The soundings marked in black colour are the depths in the channel at low-water when the river is in its state of summer water, and those marked in red colour are the depths at high-water of an ordinary spring tide rising 21 feet at Glasson and 10 feet at Lancaster. The large figures on the margin of the low-water channel indicate the perpendicular rise of tides at the places where they occur. A longitudinal section of the bed of the rivers from Lancaster to Glasson was also made. It was thought unnecessary, however, to show more of this section than that part which extends from Lancaster to Coleway, as the operations which we recommend to be undertaken, in the first instance, are confined to this stretch of the river. During the progress of the survey a register of the rise and fall of the tide was kept at Lancaster Quay, Heaton Point, and Glasson Dock, by means of graduated tide gauges, fixed in reference to a level line accurately traced from Lancaster to Glasson, and all the high-water soundings on the plan, and the heights on the section have reference to the high-water of the same tide.

To enable us to make an estimate of the probable expense of the projected improvements, we found it necessary to make a line of borings in the channel of the rivers from Lancaster to Heaton, in order to ascertain the formation of the shoals and fords to be removed. Sections were also made of the principal bays and marshes in the line shown on the plan, with the view of determining the places where the materials obtained by dredging could be deposited with most advantage or applied to reclaiming the marsh lands along the margin of the river wherever an extension of the land might be made without risk of injury to the navigation.

The fords and shoals in the upper part of the Lune form the principal obstructions to its navigation; but they are neither numerous nor extensive, and are confined to the reach of the rivers between the quays of Lancaster and Coleway Point, a distance of about two miles and three-quarters. By referring to the plan and section, on which, as already stated, all the soundings and vertical heights have reference to the level of high-water of an ordinary spring tide, it will be seen that in some parts of the navigable track there is a depth only of 12 feet at high-water. The traffic of loaded vessels of ordinary tonnage, drawing from 10 to 11 feet, is thus extremely circumscribed, as vessels of that draught can only reach the quays of Lancaster during spring tides, and even then with considerable difficulty; and when they have the misfortune to lose the high tides they are under the necessity of waiting in the river for the next springs, a delay which is attended with great expense to the owners, while the vessels and cargoes run considerable risk of damage from lying so long in such situations. It therefore becomes an object of the utmost consequence to extend the opportunities of reaching Lancaster in one tide by affording a greater depth of water, and by hastening the arrival of the tide in the upper parts of the river, and to this we have particularly directed our attention.

The first obstruction which is met with on leaving Lancaster is Scale Ford at the upper end of Salt-area, a high ridge stretching across the river from bank to bank, and extending about 700 yards along its bed. The highest part of this ford, when the river is in a very low state, is almost laid dry, and has only a depth of 12 feet at high-water. Several borings were made on the Scale Ford to the depth of from 10 to 13 feet below the bed of the rivers, and it was found to consist of a crust of hard and compact gravel about three feet in thickness, under which lies a bed of soft clay. Through this clay the jumpers were easily driven by a light hammer about a quarter of an inch at every blow.

The next obstruction is Baffler's Ford, situate at the lower end of Salt-area, and extending 560 yards along the bed of the river: when the river is in a low state it is almost dry, and at high-water of ordinary spring tides it has a depth of 12 feet 10 inches at the shallowest place. The borings made on this ford proved it to be a crust of hard gravel of from two to three feet in thickness, resting on a mixture of soft gravel and sand.

At Oxcliff, Snatchems, and Heaton considerable shoals occur, extending to 313, 516, and 653 yards respectively, along the bed of the rivers. These obstructions, however, are merely banks of sand and loose gravel, and from the facility with which the borings in that part of the river were made, there is no doubt that they will be removed with comparative ease.

The depth of water on these shoals varies from 13 feet 9 inches to 15 feet 3 inches at high-water of ordinary spring tides. Opposite the lower end of the quays at Lancaster there is an accumulation of gravel in the middle of the stream, which is by no means extensive, and will be easily removed.

To the removal of these obstructions we would, in the first place, direct the attention of the Commissioners, as the works of most importance, which must naturally precede all the others. The Commissioners for the improvement of the Lune navigation have erected an extensive weir at Scale Ford. The object of this erection, it is believed, was to cause the water which formerly passed on the north side of the Salt-area to pass down the south channel, and, by erecting an additional scour at that place, to remove the Scale Ford by the increased action of the current. The gravel of which the fords are composed, however, is of too hard and compact a nature to be acted on by such means, and the consequence is, that the weir has not produced the contemplated improvement to any useful extent.

The great object to be kept in view in carrying into effect the improvement of the navigation of the Lune, is the free admission of the greatest possible quantity of water from the sea, as reliance must be chiefly placed upon the scour produced by the tide, and not upon the current of the fresh water as the chief agent in keeping open the navigable channel of this river.

In the course of our investigations on the subject of the tides at the Lune, we ascertained the following facts, by a due regard to which we have been in a great measure guided in forming our opinion as to the best means of improving the navigation, viz :—

1st. The high-water mark of each tide is on the same level at Glasson, Heaton, and Lancaster, and the time of high-water of each tide is nearly the same at these places.

2nd. The level of low-water at Heaton is 3 feet 9 inches below that at Lancaster, and the level of low-water at Glasson is 7 feet 3 inches below that at Heaton, making the level of low-water at Glasson 11 feet below that at Lancaster.

3rd. On the 6th of September, 1838, when the tide rose 21 feet 1 inch on the Old Dock Sill, by the Liverpool tide tables, it rose 23 feet 6 inches at Glasson, 16 feet 3 inches at Heaton, and 12 feet 6 inches at Lancaster.

4th. The distance from Glasson to Heaton by the low-water channel, 3½ miles, and the distance from Heaton to Lancaster is 2 miles and ⅛th; making the whole distance from Glasson Dock-gate to the lower end of St. George's Quay at Lancaster, by the navigable channel, 5½ miles nearly.

5th. In spring tides the tide takes 1 hour and 10 minutes to flow from Glasson to Heaton, and 40 minutes from Heaton to Lancaster, or 1 hour and 50 minutes from Glasson to Lancaster.

6th. In neap tides the tide takes 3 hours 50 minutes to flow from Glasson to Heaton, and 1 hour and 10 minutes from Heaton to Lancaster, making 5 hours from Glasson to Lancaster.

7th. At Glasson, spring tides rise for 3 hours 20 minutes, and fall for 7 hours 40 minutes; and neap tides rise for 6 hours, and fall for 6 hours; and at Lancaster spring tides rise for 1 hour 40 43 minutes, and fall for 4 hours 10 minutes, and neap tides rise for 1 hour, and fall for 2 hours 40 minutes.

Proposed Improvements.

From a consideration of these data, and the depths shown on the section, it is obvious as already stated, that the natural mode of improving the navigation of the Lune is to remove the fords, and other sudden changes in the form of the river's bed, so as to reduce the injurious effects of these obstacles in hindering the free ingress of the tide, as well as to afford a greater depth of water for vessels of a certain draught in the upper parts of the river. The advantages of such a change in the circumstances of the channel are twofold, for not only will vessels of greater draught be enabled to pass those shallows at high-water, but the more free and unimpeded flow of the tide, which must be the result of deepening the upper parts of the river, and removing the ridges which oppose an earlier entrance to the waters of flood, will give vessels a better chance of reaching the upper parts of the navigation at the proper time, by enabling them to start at an earlier period of each tide.

The operations which we propose may be divided into two compartments. The Commissioners should, in the first instance, confine their attention to the deepening of the present navigable channel in the upper part of the river. By this means, as already stated, the tide will be brought earlier to the quays of Lancaster, and this reach of the river will be rendered suitable for vessels of a greater draught of water than those at present employed in the trade of the port. For this purpose the several fords and shoals which have already been enumerated must be excavated to the extent shown in red colour on the longitudinal section, which would afford a depth of 16 feet all the way to Lancaster Quays in ordinary spring tides.

We are happy in being able to state that this operation will be attended with very little difficulty, and may be effected at a very small expense, while the benefit which the port of Lancaster must undoubtedly derive from it will be very considerable. The borings and examination of the subsoil of these fords have proved that the materials of which they are composed, although generally of a compact and hard nature, are nevertheless such as may be easily removed by a steam dredging machine of moderate power, and of the ordinary construction, applied and worked with care.

It is conceived to be an object of great importance to obtain a sufficient depth of water up to the quays of Lancaster at as early a period as possible. We have, accordingly, restricted their estimate of the improvements, in the first instance, to the formation of a channel 100 feet in breadth, having a depth of 16 feet at high water of ordinary spring tides, which rise 21 feet at Glasson and 10 feet at Lancaster. This important improvement in the navigation might be accomplished with one dredging machine in the course of one working season, at the expense of 7425*l.*, including the cost of a dredging machine and punts, all of which would afterwards be applicable to the further improvements of the river.

The second stage in the operations of the Commissioners would embrace the widening of the channel and the straightening of its course by cutting off the projecting points within the red dotted lines delineated on the plan. In this way a still greater volume of tide water would be admitted to flow freely up the river, and the passage of the tide from Glasson to Lancaster would be proportionably accellerated, while the navigation would be rendered more easy for the increased number of vessels, which, after the deepening of the channel to 16 feet, would come directly to the quays of Lancaster.

The widening of the river could be carried on with the dredging machine at an annual expense of about 1750*l.*, and could be completed, to the extent shown in the plan, in the course of three or four years, if the operations were formed on an extensive scale. In regulating the extent of their ultimate operations, the Commissioners would, of course, be guided by the prospect of a further increase of the trade and revenue of the port, which the effects of the first season's operations might afford, as likely to be the result of more extensive improvements.

The whole scheme proposed to the Commissioners might thus be completed in the course of four years. If the increase of trade should then warrant a further extension, the Commissioners might proceed to deepen the river from 16 to 18 or 20 feet, when it would be also necessary, in order more easily to preserve the increased depth, to widen the river at the site of the old bridge by removing its ruins which encumber the stream, and perhaps even to extend the dredging operations as far as the new bridge.

We are aware that some doubts may exist as to the possibility of preserving the proposed depth of 16 feet when once obtained; but after a careful examination of the river itself, both by boring and otherwise, we have no hesitation, from our experience on other rivers, in saying that the occasional use of the dredging machine, assisted by the natural scour of the tide passing four times over the river in 24 hours, will preserve the depth and breadth of channel, which we have recommended to the consideration of the Commissioners.

APPENDIX.

No. 27.

The only subject connected with the proposed improvements that remains to be considered is the disposal of the gravel and other matter excavated from the river in forming the channel.

Several low lying tracts of land on the margin of the river might, with advantage to the proprietors and convenience to the Commissioners, be enclosed, an operation which has already been carried to a great extent at Adcliff; but we beg leave particularly to point out the necessity of using much caution in encroaching on the tide-covered banks of the river, and thus shutting out large portions of the tide water, and impeding the effect of that powerful, constant, and therefore most efficient of all agents in preserving the depth of navigable channels.

That we might be fully able to advise the Commissioners as to the means of disposing of the excavated stuff to most advantage, so as to keep in view the improvement of the navigation as the object of most importance and the acquisition of land as a secondary consideration, they made sections of all the large bays and marshes on the margin of the rivers. These were Ovangle, Heaton, and Coleway marshes on the north side, and Adcliff Bight, Thornbank Bight, and Conder Bay, on the south side of the river. The result of these sections is, that Ovangle and Coleway marshes are those which could with most advantage be enclosed. We have formed this opinion from the consideration that these portions of land lying on a higher level could be enclosed at much less expense and with much greater ultimate advantage than any of the others, while the quantity of water excluded by the operation will, of course, be less in proportion to the height of the present surface of the marshes.

The quantity of stuff which would require to be excavated during the first season's operations in deepening the channel to 16 feet at high water is about 60,000 cubic yards. On Ovangle Marsh an embankment, containing about 23,000 cubic yards, placed in the position shown by dark green lines on the plan, would inclose about 55 imperial acres, and this could be easily overtaken during the first season's operations.

The quantity of land which would be gained by enclosing Coleway Marsh is about 80 imperial acres; but the quantity of stuff required to form the embankment for this purpose is about 128,400 cubic yards.

A portion of land extending to about 30 acres could, however, be enclosed at the east corner of Coleway Marsh during the first year's operations by an embankment in the position shown by dark green lines on the plan, containing about 54,000 cubic yards.

We have not the means of knowing which would be the most advantageous position, in a pecuniary point of view, for the Commissioners, as that must depend on the views of the proprietors and the arrangements that can be formed with them. We have no hesitation, however, in saying that, in an engineering point of view, the choice lies between Coleway and Ovangle Marshes, and that in adopting either, or indeed both of these positions, (should the future operations of the Commissioners require it,) the navigable capabilities of the river would not be injured, as both of the marshes in question lie on a high level, and are pretty far removed from the natural flow of the river.

Before concluding, we beg leave to draw the attention of the Commissioners, as conservators of the Lune navigation, to the necessity of exercising the right which they possess of enforcing the removal of the numerous stake and bag nets which at present project into the navigable fareway. These obstructions not only distort the natural flow of the river, but in fact present impediments of the most dangerous description to the vessels navigating it.

We, therefore, humbly suggest the propriety of the Commissioners enforcing their right of removing them, before the occurrence of some serious accident shall render this step imperiously necessary.

Probable estimate of the expense of improving the navigation of the River Lune, so as to obtain a depth of 16 feet at high water of ordinary spring tides up to the quays of Lancaster, by Robert Stevenson and Sons, civil engineers:—

		£.	s.	d.
Expense of a dredging machine worked by an engine of 12 horses' power, with punts and apparatus.		5,000	0	0
Ten months' work of a dredging machine, at 175*l.* per month		1,750	0	0
		£6,750	0	0
Incidents on the above sum of 6750*l.*, at 10 per cent.		675	0	0
		£7,425	0	0
To complete the further improvements of widening and straightening the channel shown in the plan—	£.			
Three seasons' work of a dredging machine, taken at 1750*l.* per annum	5,250			
Incidents at 10 per cent.	525			
		5,775	0	0
		£13,200	0	0

Edinburgh, December 14, 1838.

ROBERT STEVENSON AND SONS.

No. 28.

No. 28.

Statement relative to the River Dee in Cheshire. *By* DAVID STEVENSON, *Civil Engineer.*

Edinburgh, June 24, 1845.

I SURVEYED the River Dee from Chester to Flint in the year 1839, with reference to the improvement of its navigation, at the desire of the "Chester Dee Improvement Committee." I also in 1840, surveyed the upper part of that river from Chester to Pulford Brook for the Marquis of Westminster, with reference to the improvement of the drainage of the upper district.

Distances.

The Dee rises in Merionethshire from the Lake of Bala, and, after a course of about 60 miles, reaches the city of Chester, which is 25 miles from the Bar. The following are the distances.

The Bar to Point of Ayre	4 miles.
Point of Ayre to Flint	10 miles.
Flint to Connah's Quay	3¾ miles.
Connah's Quay to Chester	7¼ miles.

The part of the river which extends from the Bar to Connah's Quay, 17¾ miles, may be said to be an open estuary, and the part from Connah's Quay to Flint (7¼ miles) is an artificial tidal canal, about 500 feet in breadth, the available breadth of which, however, is reduced to 250 feet by means of a series of groins or jetties projected from the southern bank. From the weir, immediately above the city for the use of the Chester mills, upwards, the river is dammed back, so as to present the appearance of a narrow lake, having a sluggish current through it.

Tides.

The influence of the tides is greatly checked by these groins, and especially by the weir, but as high springs rise four feet above this weir, their influence is felt at Pulford Brook, seven miles up the river; how much farther I am not aware.

Depth of Water.

At the time the survey was made (1839) in many places the depth was 13 feet at high water, ordinary spring tides, and the available depth for shipping to Chester 12 feet.

The high-water line was found, by an average of twenty-four observations, to rise two inches from Flint to Connah's Quay; and from Connah's Quay to Chester the rise was found to vary from four inches at neap to 14 inches at spring tides, giving, as the result of twenty-four observations, an average rise of six inches. The whole average rise on the high-water line from Flint to Chester is therefore eight inches.

The difference between the times of high water at the different stations was found to vary very much, and appeared to be more affected by the state of the winds, or some other cause unknown, than by the circumstance of the tides being neap or spring; but the average of the observations gave the time of high water at Flint twenty minutes earlier than at Connah's Quay, and that of high water at Connah's Quay thirty minutes earlier than at Chester, the whole average difference in time between high water at Flint and at Chester being fifty minutes.

The average level of the low-water line at Connah's Quay is 2 feet 6 inches below that at Chester, giving on the distance of 7¼ miles an average fall of 4·09 inches per mile, and the level of the low water at Flint is 7 feet 6 inches below that at Connah's Quay, giving on a distance of 3¾ miles an average fall of 24·59 inches per mile. The total fall from Chester to Flint is 10 feet, being an average fall on the distance of 11 miles of 10·9 inches per mile.

When the rise of tide as indicated by the Liverpool Tide Table is 18 feet on the Dock Sill at Liverpool, the rise in the Dee is 20 feet 10 inches at Flint, 13 feet 8 inches at Connah's Quay, and 11 feet 5 inches at Chester.

Formation of Bed.

The bed of the river from Chester to the sea is soft, consisting entirely of sand without any admixture of gravel. Above the weir at Chester mill the bottom generally may also be said to be soft, but two fords of harder material occur, viz. "Watling Street," and "Broughton Fords," the former five and the latter one mile above the weir. Watling Street is composed of stones, supposed to be in the line of the Roman Road from Chester to London, &c. Broughton Ford is composed of sand and gravel.

The case of the Dee is peculiar as regards its navigation, having been improperly treated, first, by the erection of the weir for working the Chester mills; and secondly, by extensive embankments formed for reclaiming land.

Weir.

The height of the weir above bed of river is 11 feet 6 inches; and the level of its top, if extended up the river, does not cut the bed at any point within the range of my observations, which extended seven miles to Pulford Brook. The level of the surface of the water at Pulford Brook is 2 feet above the weir, which is equal to a fall of 2 feet in 7 miles, or at the rate of 3·42 inches per mile. The obstruction caused to the tides by this weir is most prejudicial, as none but the highest tides extend above it, whereas, were it removed and the Watling Street and Broughton Fords taken away, a vast increase would be given to the daily amount of the tidal scour. The consequence of removing this weir appeared so formidable, however, as affecting the mill property, that the Navigation Committee of Chester, by whom I was employed to report on this point, could not attempt such an operation. This weir also acts injuriously in greatly aggravating the floods, which are often most destructive to the upper lands; on the prevention of which I reported to the Marquis of Westminster, and proposed lowering the weir at least five feet.

Embankment.

The Dee Company were incorporated by Act of Parliament, it is believed, in the year 1732. They received powers to embank and possess the land on the estuary on condition that they kept up a 16-feet navigation to Chester. By a subsequent Act the depth was reduced to 15 feet. They accordingly proceeded to embank, turning the river aside by abrupt and injurious bends, and that embankment now extends to below Connah's Quay, 7¼ miles from Chester, and encloses, it is believed, about 4,000 acres, and a large additional quantity is now becoming ready for inclosure.

State of Navigation.

The part of the navigation to which my attention was specially directed by the Committee, and which was surveyed, is shown on the plans accompanying this Report. It may be divided into two compartments, both of which are navigated with difficulty; one compartment extending from Chester to the end of the Dee Company's embankment at Connah's Quay, and the other from Connah's Quay to Flint. The greatest deficiency and irregularity in depth is in the upper of these compartments where the currents have been distorted by the bends in the channel, and the groins or jetties which have been projected into it; while that below presents obstructions to shipping, chiefly on account of the tortuous and shifting nature of the channels. The channel of the Dee below Flint, although tortuous and like that of many other estuaries, liable to change its direction, is nevertheless at high water of sufficient depth for the largest class of merchant vessels.

Improvements proposed.

The improvements proposed as the result of the survey were, *first*, cutting and widening of the banks of the river at Chester. *Second*, improving the towns below the Cheese-house, near Chester. *Third*, altering the line of wall at Connah's Quay, and *fourth*, extending a dwarf rubble causeway, three feet above low-water mark from the Barrel Perch to the Pentre Rock, a distance of two miles and 40 feet.

In connexion with these works, dredging the bottom was to be carried on, and these different works were estimated to be executed for the sum of 24,905*l.* 10*s.* 9*d.* in the course of 12 or 14 months, and a depth of 16 feet at high water of spring tides obtained. Twenty feet might be got for 20,000*l.* additional; in all, 44,905*l.* 10*s.* 9*d.*

No. 29.

Wells Harbour.—Case of Embankments.

"Your opinion is desired, whether embankments made as above stated, which totally stop the flow of the tidal waters into the creeks and channels and over the marshes, where they were wont to flow and reflow, for the keeping open and deepening the harbour and channels of the port of Wells, and in one of which creeks, before the first embankment, a navigation of boats was carried on, are not nui-sances. And if you are of opinion they are, in what manner you would advise the traders and inhabitants of Wells, who would be so materially injured by the continuance of them, to proceed for getting them removed. And if the Commissioners under the Act should think it right for them to interest themselves in removing and abating the nuisances, have they power to apply any part of the monies, raised under the Act obtained in 1768, in pursuing such means as you shall advise?"

Copy of Serjeant Grose's Opinion, 31*st January*, 1778.

"I am of opinion, that all the embankments, which, by preventing the flow and reflow of the tides, stop up the harbour, and are prejudicial to the navigation, were nuisances at the time they were made; but some of them have existed so long that there will be some difficulty in getting them removed; the best way to attempt it will be by indicting those persons who have made or continued the last of the embankments which are prejudicial to the harbour. It would be of too dangerous a consequence, I think, to attempt to abate them, by pulling them down, because the mischief might be infinite, and might be prejudicial against those who endeavour to remove the nuisance. I think the Commissioners, under the Act for preserving the harbour, by virtue of that clause which enables them to do what they think fit for the purpose of improving and maintaining it, may apply as much of the money raised under the Act in support of such a prosecution will, in my opinion, be doing that, which will assist to improve and maintain the harbour; but before such indictment is preferred, or anything done towards removing the embankments, I would recommend an application to be made to the lord of the manor, stating the inconveniences occasioned by the embankments, and begging him to remove them. If he sees the application in its proper light, I think he may find out some plan to remove the nuisance complained of, without doing much injury to the land embanked, which would be the most desirable object on both sides."

Result, 1779 *to* 1784.

"It appears that three trials took place in the Court of King's Bench, and that two verdicts were found for the Commissioners. On the last trial, the Court allowed for costs and expenses 562*l*., which was paid by the representatives of Sir John Turner. An injunction which had been granted by the Court of Chancery, in 1781, restraining them from removing the banks, was dissolved, and they were at liberty to throw down the same. After these proceedings, it appears by a minute, that the water upon a spring tide flowed as far as the ancient limits of the port, by which we may infer, that the banks were all removed.

"The first indictment was preferred by the Commissioners of Wells Harbour, against Sir John Turner, and tried at the summer assizes at Norwich, 1779. Verdict found by the jury to be 'a nuisance.' This indictment was afterwards removed into the King's Bench, and intended to be tried at Norwich, but prevented by the death of Sir John Turner. It would appear subsequently from many remonstrances, that the trustees of Sir John Turner, rather than allow the banks to be forcibly removed, (of which the Commissioners of the harbour gave notice,) consented to an action. And after two trials, before special juries of Norfolk, at Norwich, two verdicts were obtained. Those were confirmed by the Court of King's Bench. The leading counsel, George Hardinge; solicitor, Mr. Jones, of London. The periods between 1781 and 1784. The appeal to the Lord Chancellor was in 1781. Folkes, Bart., and Hales, plaintiffs, (trustees of Sir John Turner), and Harbour Commissioners of Wells, Scarlet and Brown, were defendants. Mr. Elliott, engineer. No report recorded.

"In 1839, Wells Harbour is in fair order. Several banks have been removed recently. A bank at a very heavy expense has been erected across the main creek, which has diverted the channel, by which means the water is retained for a longer period in the harbour, which provides plenty of back-water until the ensuing flood tide. Spring tides usually flow 11 feet at the quay.

"The harbour was deprived of the usual operation of the tides, by the embankments from 1758 until 1784, when they were removed. In 1839, the revenue of Wells Harbour was between 500*l*. and 600*l*. per annum."

No. 30.

No. 30.

Extract from a Report by Mr. C. Rand on Rye Harbour.

The blowing up of Scott's Float Sluice seems to have occasioned great alarm to the owners and occupiers of lands, supposed to be dependent on this sluice for their protection and security against the influx tide-water, and for the carrying off the common follow and downfall freshes of rain-water, thereby preventing an accumulation from overflowing and inundating the levels, or low lands, by either the salt or fresh water.

Invited to give an opinion upon the best mode of draining off, and securing in future the lands now under water, in consequence of this apparently disastrous affair, the loss of the sluice, I took a view of the levels and flooded lands, and of what had happened at Scott's Float; and from many observa-tions, and being no stranger to the principles of action and power of the sluice at that place, as a security from inundation by the influx tide (salt water), or for the draining the levels of their incum-bent flood-waters, I could not look upon its destruction in any other light than as likely to afford great relief to the long and most grievously oppressed lands above it; feeling at the same time the temporary inconvenience that must be sustained until proper embankments can be raised for their security, and which ought to be forthwith taken in hand; but to erect anything of the kind of the demolished sluice* for permanent protection, would, I think, and hesitate not to say, be deviating largely from the purest and best principles of hydraulic engineering, and a libel upon common sense. (On or about the site of the late sluice, Government may be disposed, if applied to, to connect a public bridge with their military works.)

During many years of public employment (in the civil department of the Ordnance as surveyor) the duty of the service had frequently occasioned me to be at Rye, where I embraced every opportunity that offered of making observations to gain local, as well as general information on the state of the harbour at that place,† as well as the levels above noticed, so materially dependent upon a good outfall to sea, and having been permitted to employ my leisure in works of civil engineering, I had, during one of my professional visits at Rye, a drainage in hand of two large levels; one of which, in similarity of feature, and other general circumstances, much resembling the lands through which the Rother runs, and which lands I had often viewed with much concern at their not being better drained, the great impediment to which always appeared to me to be the injudiciously placing a sluice in the tide's-way, equally objectionable, as ineligible to the well draining the land, and ruinous to the free navigation of the river.

Having carefully viewed the levels immediately on the direct channel of the Rother, from and between the lands at Dixter's and Padeham, and the place of Scott's Float Sluice before-mentioned, and having noticed the soundings of the channel of the river, taken proper sections of the same, and the water-way at the several bridges, viewed particularly the state of the embankments, and obtained, from the best information I could get, the number of acres then (2nd November) under water, called the wet level, &c., I have no hesitation in offering an opinion, and of giving a decided preference to an open tide's-way river, as the best possible mode of draining the levels, and for the protection and security of all the lands from being injured by the sea-water or land freshes, to embank substantially, to a level not less than three feet above the line of the highest known tide or flood, and to introduce into such embankment a suitable number of the best-formed drain trunks (those at present on the river are of the worst construction), giving a clear foreland to the seat of the banks, of seven yards on each side of the river, to enlarge the passage of the water-way, to carry off great downfalls of rain.

It may be argued by favourers of the sluice scheme of drainage, that the tide's water cannot affect the lands above it, inasmuch as it will be kept back by the sluice-gates whilst the tide is running in. Granted; but such stop-gates tend to the silting up the bed of the river and harbour below, to the ultimate ruin of the drainage, whilst the whole body of the sluice acts as a mud-trap, to choke up the channel of the river above, which by the free influx and reflux perhaps of the tides alone, with the usual follow, would keep the channel at all times well scoured. But should there be a deficiency of power in this respect, the freshes running off to sea, through an uninterrupted channel, would effectually cleanse it, and maintain its bottom, to give the better action to the drain trunks placed in the embankments.

To adduce proofs in support of the open-river mode of draining, and the securing the lands by embankments, with proper out-fall drain trunks, would be to name all the best drained lands in England situate on tide rivers; and this mode of draining being adopted, has reclaimed and laid dry many thousands of acres in this county (Sussex) under my own immediate direction, which had been overflowed and oppressed for ages before the removal of sea-sluices placed in the tideway.

And so perfect has the drainage been made, by adopting the above means, in one level of about 4000 acres, that in many places where sea birds used to resort at the time of their incubation, and where sometimes they would continue all the year round, among the swamps and bogs, fine crops of corn have grown, and continue to be produced; and the above lands may fairly be stated improved in their value nearly 200,000*l.*, on the expenditure of something less than 20,000*l.*, in carrying on the works of drainage, and improving the navigation.

For the above, and other equally substantial and scientific reasons, which might be brought in support of the arguments in favour of the open tide's-way mode of drainage, in preference to the stopping up so valuable a river and drain channel as the Rother is, by a sluice of any sort or size, I must beg again to offer it as my best opinion, resulting from experience, not only to recommend, but to urge the necessity of the tide's-way drainage as the best possible security for the land, independent of the benefit arising from an improved state of the navigation,—"To adopt the plan of embankments and drain trunks," and to abandon as erroneous in principle—as injurious in practice—and probably as much more expensive, every idea of the sluice scheme, which originally ought never to have been suffered to have been put down, and, it is presumed, cannot legally be maintained.‡

Lewes, 11*th November*, 1812.

(Signed) C. Rand.

No. 31.

Extract from a Report of Mr. John Rennie, respecting Rye Harbour.

December 26, 1812.

By comparing the sections which Mr. Giles made of the Rother, from Scott's Float Sluice to the fish-market at Rye, in 1804, with those that he made in October last, it appears that by the destruction of Scott's Float Sluice, and the tide being in consequence allowed to flow up the channel of the Rother, a considerable increase of depth has taken place, not less than two feet. What additional depth may have been acquired from the fish-market at Rye to the harbour's mouth, I have no correct means of ascertaining; but it must be considerable. I am also informed that the levels which sew into the Rother below Scott's Float Sluice, have been greatly relieved by the increased depth of the river, and that the water passes from thence in much less time than it used to do while Scott's Float Sluice was in existence.

The facts above stated are exceedingly satisfactory, and clearly show the injury which is occasioned to harbours by the shutting of the tides out of their ancient channels, and by embanking the marshes

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* In the channel of the Rother.

† It was my usual practice, whenever my professional engagements called me, to notice and take minutes of all public works.

‡ Vide Dugdale's Report, River Rother, 22nd edit., 3rd, &c.

APPENDIX.

No. 31.

and mudlands over which they used to flow; and proves, in a decided manner, the propriety of the opinion given to the Commissioners of Rye Harbour, by Mr. Jessop, and myself, in February, 1801, respecting this embankment of the marshes on each side of the said harbour, and which at that time seemed to be considered by the parties interested as a matter of little importance to the harbour itself. But although, as a general principle, the facts are incontrovertible, there are cases where this principle may be abandoned with propriety, and the question is, whether this is one of these cases?

It has already been stated, that since Scott's Float Sluice was blown up, and the tide-water admitted freely into the Rother, that the channel, from the ruins of the said sluice to sea, has been deepened, and the sewage of the levels below the sluice materially improved; and I have no doubt, if things are allowed to remain in their present state, a further improvement will still take place.

No. 32.

No. 32.

Extracts from the Report of Mr. Daniel Alexander, on Rye Harbour.

November 18, 1813.

In obedience to your instructions, communicated to me by Mr. Francis Hickes, I put everything aside, and repaired to Rye, in company with him, on the 15th June last, and took the low and the high waters of the 16th and 17th of that month, being the 2nd and 3rd days after the full moon, to make a survey of the harbour of Rye, from the low-water mark up to Newenden Bridge.

Rye Harbour being a question which had employed the best consideration of the public for a long time past, I was favoured, by Mr. Weston's kindness and assiduity, with the various historical papers following, viz. :—

A Report of 1698, condemning all projects of improvement, "as the old (eastern) harbour, they say, is reduced to two or four feet water at low water; and is lost."

Ditto of 1719, suggesting the widening of the new (westernmost) channel, and taking away the dams or sluices, which prevent the flow of the tide.

An Act of Parliament, 1722, directing the dams to be opened.

Ditto, 1723, abandoning (after much controversy) that plan, and substituting a new (westernmost) channel for the harbour.

A Report, 1743, stating progress made, but doubting whether, when made, the new (western) harbour will be so good as the old one.

A Report, 1763, by Mr. Smeaton, containing plans for perfecting the new (western) harbour.

An Act, 1764, adopting Smeaton's plan.

Ditto, 1778, that plan having entirely failed, making alterations in the plan.

Ditto, 1797, repealing all former Acts, discontinuing the new (western) harbour altogether, and substituting a little work to be done in the old (eastern) harbour.

A Report, 1812, made by Mr. Rand to the Commissioners of the harbour, after the blowing-up of Scott's Flat Sluice, proposing the method of embanking, for the better draining the land, and deepening the old harbour, too.

And a Report, 1812, made by Mr. Rennie to the Commissioners of Sewers, of two methods for securing and draining the levels, one of which methods applies to the harbour.

It will shorten what I have to remark, if I here state once for all, that by "Collins's Coasting Survey," a work of esteemed authority, in 1683, the old (eastern) harbour of Rye was capable of accommodating vessels drawing from 12 to 14 feet, afloat at low water, and with a fair channel to sea; although I am of opinion, that if these soundings are correct, they were taken many years before Collins's time; because the decrease of water could not have been so sudden, in so few years, as stated in the next paragraph.

That then, and subsequently up to 1698, "the encroachments (I quote a sentence of the Report of 1698) on the tidal waters and innings of the lands upwards in the country, had almost entirely shut out the sea, so as to cause the harbour to be almost entirely lost, with a continued bar of not more than 2 to 4 feet at low water."

That the plan or project of 1718–19, went (with other works) to remove the dams or sluices; which removal was, by an Act of 1723, hindered from being put into execution. That in consequence of such non-removal, it was found, in 1743, that the new (western) harbour would not probably be better than the old (eastern) one.

That Mr. Smeaton's plan, in 1763, for perfecting the new (western) harbour, completely failed, owing to his not removing the dams, and on the contrary proposing additional dams or sluices, and so preventing the influx and reflux of the tide; and also, by his running out works on the western side of the entrance to prevent the fulls (which are large banks of shingle thrown up by the south-westerly winds all along this coast) from coming down from the westward. These fulls have long since covered up everything which he then did, and have filled up that outlet of the river, and reduced the harbour, which Rye now possesses, merely to the old (or eastern) harbour.

That in September, 1812, Scot's Flat Sluice or dam, was accidentally blown up; by which means about 600 acres of land, in different levels, were, for a certain time, destroyed (as to yielding any produce) by the overflow of salt water; and by which, in a very few months, the river above and below Scot's Flat, became much cleansed and deepened, and the harbour, too, deepened in a very considerable degree, and all the levels below Scot's Flat much better drained, to an extent I am told of 26,000 acres; while the part injured amounted, as above, to only 600 acres, forming part of the upper levels, containing about 4,000 acres altogether.

That the recommendation of Mr. Rand, is, to remove all dams in the tideway, and embank the river by marsh walls to above high water spring tides,

That Mr. Rennie reports in principle the same, but with reference only to the removing the evil from the 600 acres of drowned lands, which case only was referred to him by the Commissioners of Sewers; and that this embanking system, involving the deepening the harbour as its certain beneficial consequence, would cost 30,000*l*., and the restoring the dam and sluice 20,000*l*., leaving the Commissioners to choose which scheme they would adopt, and determine accordingly. And, finally, that the Commissioners of Sewers adopted the dam and sluice, and in April last begun the same, in consequence of which the harbour is now rapidly silting up again.

Thus the history of Rye Harbour, for nearly two centuries, has been a question of balance of value between the nautical point of a harbour, and the agricultural one of the low lands, near it, in which the latter has encroached on and annihilated the former, as far as the existence of any competent harbour goes.

It would appear to me that a harbour, such as it was in Collins's time, would be effected in the site of the present or old harbour, if the quantity of land then subject to be overflowed by the tides, was again laid open to the sea; and that it cannot be accomplished by any other means. The question then is, what benefit, considering the low lands already embanked to remain so, can be effected by other means.

Now I have no hesitation in saying, from a careful review of the circumstances, that the most perfect drainage of all the low lands both above and below Scott's Flat, and of deepening the harbour, that can now be effected, would be, by removing all dams or sluices across the tideway, and by giving the flood and ebb of all tides a perpetual and unrestricted current.

The whole district of low lands on each side of the Thames and Medway (which are prodigiously extensive and valuable, and are, many parts of them, many more feet lower below high-water mark than any of these lands near Rye and the Rother are) is all drained by an uninterrupted natural sewage, to as near low water as may be, through the banks or marsh walls next the tideway, and without any dams whatever to obstruct the tide therein. This observation opens the way for the embanking proposition of Mr. Rennie, proposed also originally by Mr. Rand; which is very properly designed and stated in Mr. Rennie's Report, as amounting in estimate to 27,000*l*, and which, to effect any permanent improvement in the harbour, must still be executed, notwithstanding all the money expended in Scot's Flat; for this, in regard to the harbour, is money thrown away; and in regard to the drainage of the up country, not so good as the embanking: but under regulations (as it is executed) it might be made at times subservient to the purposes of the harbour, though it ought never to have been put up for that purpose.

In addition to this embankment it would be necessary to lay down certain inclined jetties or groins of low wicker or fascine work, to confine, restrict, and direct the channel of the river, below the town, into much narrower limits than it now occupies, and by consequence increase the depth of water, and shorten the passage from sea up to the town—and these I estimate at 2,500*l*. These wicker works should always be kept highest in point of level at the sea end of them, in order to cause what comes in with the flood to sew out from the Forelands, behind the said wicker work, at a point as far up the harbour as possible, and thus increase the column of water which shall every tide flow through and down the channel.

Also to carry on and continue the present foot wharfing and wicker work along the eastern bank of the channel, as far towards low water as may be; so as to occasion the forelands east of the said channel to swarve up behind it, in order to confine the ebb tide into a narrower width, and thereby deepen the channel accordingly; and with this view I would particularly recommend, if nothing more was ever done, that the finishing the foot wharf and wicker work now in hand, should be carried out as far as possible. I estimate this at about 2,000*l*. more Though the greater the length when executed, the more expense and the more benefit.

Another subject of some import, is, that I would propose to embank all the salts south of the town, by cutting away the margins next the river, to as low as may be between high water neaps and low water neaps, throwing parts of the excavated matter up to form the said embankment, so as to prevent the sea overflowing these salts; and leaving the seaward parts (which I will call forelands) to be covered at every tide, with the flood to run out on the ebb and add to the scour every tide; and this daily effect to be in lieu of the small quantity of water, which now covers these salts, a very shallow depth, at the top of the high spring tides; the run of which, therefore, is only at the very gentle turn of the tiptop of the tide, is consequently soon over, and has therefore very little effect.

The expense of this, I apprehend, will be paid by the land gained, and the benefits be very considerable to the harbour, so that this object may be said to cost nothing.

There is a salt marsh, close under the town, to the eastward, on which, at the least expense I have ever seen, a wet dock might be made, to keep shipping of considerable draft afloat at low water, to load and unload to any extent, with perfect security to trade and the revenue; although this is an object of comparatively future consideration, yet it is proper here to mention it; about 9000*l*. would effect this.

Thus Rye Harbour may be improved, and its channel kept clear, in 3 feet to 4 feet water at low water, with a spring tide of 20 feet to 22 feet, and the neaps of 12 feet to 14 feet at the following cost:—

1st.	By discontinuing the use of, or by the removal of Scott's Float Sluice, and by embanking and other works above it	£27,000
2nd.	Groins below the town to direct and confine the channel	2,500
3rd.	Wicker works towards low water	2,000
4th.	Embanking salts, and excavation of forelands, for overflow of neap tides.	—
		£31,500
5th	A wet dock at a future period	£9,000

Rye, at present, is a tidal harbour; accessible to ships of moderate draft of water upon the flood, and from and after half tide, which tides are favourable to navigation in the bay, being without any cross set, occasioned by the projection of Dungeness to the south-east.

South and south-westerly winds cause a heavy sea on the western side of the entrance of the harbour. If the harbour was so far restored as to give 14 to 16 feet draft of water at half tide, vessels of good draft might get into safety in the harbour, secure from all winds, and lie afloat, at low water, in a wet dock, made close to the town, very convenient to commerce and revenue; but it would be difficult to get to sea again with the wind from east-south-east, round to west, unless the weather was moderate.

Transports, the general average of merchant-men, and the smaller classes of ships of war, taken short with a contrary wind, might find shelter in Rye; but, under these circumstances, it would hardly be a port for a convoy, or a fleet to run to, except from the enemy's cruisers; for they, as well as ships of war on the Dungeness station, might find shelter without going into Rye from easterly gales, when bound eastward, under the west of Dungeness, where there is excellent anchorage; as well as also on the contrary from westerly gales, in the road under the east of Dungeness; and in southerly gales of wind, which bring the enemy out of his ports, men of war would choose to keep to sea, except when they want to refit.

As Rye lies in a bay, almost three miles to leeward (in most prevailing winds), of a line from Fairlight Point to Dungeness, it has occurred to me, that the great object to the town and port of Rye, and all the up-country connected therewith, as well as to the kingdom at large (for there is no good harbour from Portsmouth to the Downs), would be to render the port of Rye a weather harbour, by running the course of the Rother along the Flats south of Winchelsea, and so out to sea just under the eastward of Fairlight Point; but I have not looked at the country or coast, except on the charts, with this particular view.

Finally, looking at Rye commercially as a port, if restored as above, it is to be recollected, that from this port great quantities of oak timber and plank are shipped for the navy and merchants' service; as also bark, wool, hops, and corn, all drawn from the wealds of Kent and Sussex, of which the river Rother is the natural outlet: and as the Rother is navigable to Bodiam Bridge, so it is the receiver, through Rye, of all the coals, lime, stone, and shingle, for roads used a great way up the country, and for the extension of which navigation, through Robertsbridge, Etchingham, Ticehurst, and Mayfield, application to Parliament is now making; in addition whereto the navigation, for which an Act has passed to join the rivers Rother and Medway, will enable a constant communication between London and the British Channel, through the port of Rye direct, in a south-westerly direction, without going, as now, easterly, southerly, and westerly, with so many winds required up channel, round and about the South and North Forelands, and up the Thames.

I have the honour to be, Gentlemen,
Your most obedient Servant,
(Signed) DANIEL ALEXANDER.

No. 33.

No. 33.

Report of Mr. Cubitt on Rye Harbour.

London, April 17th, 1839.

Having been called upon by letters from Mr. Manser of the 28th of January last and subsequently, to inspect the harbour of Rye, with a view to my reporting upon the works that may be required for its improvement, I have now the honour to submit to the Commissioners this Report upon the subject; premising that I went down to Rye on Thursday last, the 11th instant, and devoted the two following days to a survey or inspection of the harbour and works, and making such examinations and inquiries relative thereto, as I deemed necessary to the execution of the duty required of me.

Adverting to my former Report of July, 1833, it will be seen that I then recommended certain works to be done within the harbour, that is, above the entrance at the old Pier Head; such as straightening and deepening the river's course, taking off bends, diverting the flood and ebb streams into a uniform channel, &c.; together with some slight works of reparation at the harbour entrance, both on the eastern and western sides thereof: but leaving the great question of permanent works between the harbour entrance at the pier and the low-water mark at sea, until some future opportunity, after the works of embankment, &c., under the then new Act of Parliament, should have been completed.

Since that time, however, little or nothing appears to have been done towards deepening, altering, or improving the river channel, which remains very nearly in the same state it was six years ago, except being a little worse; but the circumstances at the mouth of the harbour are very much changed since that time; the whole of the piling or groyne works are removed, and the mass of beach or shingle which was accumulated behind them is gone; a considerable length of a rubble stone pier or breakwater has been erected from the old pier head in a direction south-half-east to the extent of 1500 feet, at a height of 10 feet above low-water, so that on the whole, the harbour entrance is certainly improved in appearance, and is in my judgment certainly better than it was in 1833, but whether this improvement be wholly owing to the eastern works which have been erected, or whether other circumstances may not have contributed to its improvement is a matter of doubt, inasmuch as it appears that during the interval, about 400 acres of land within the fulls, have been embanked off from the tides, and thereby lessened the indraught and range of the surf at high and raging tides, which had a great tendency to bring shingle to, and even into the mouth of the harbour; it is my opinion that this circumstance has had its due share in the improvement of the harbour, and that good would arise if the tides could at any reasonable expense be kept entirely out of the main fulls.

As regards the main question which has so long agitated the minds of many persons interested in the improvement of this harbour, and in either case as I believe with an equally sincere wish for its improvement, by those who advocated either of the methods proposed, viz., whether eastern or western works were best as a general principle of improvement to the harbour? I can state this much, that in my judgment the harbour may be improved, and a straight channel formed and maintained from the pier head across the sands to the sea, by means of either eastern or western works, with different degrees of efficiency and different amounts of cost; but as one method has been already adopted and carried out to some extent, and with apparently good effects, I have no hesitation in strongly recommending that the continuation of the east stone breakwater be steadily and constantly persevered with in short lengths, so as to give time for the current to excavate the foundations, in turning round its end to the eastward, as the work proceeds, and that it be carried on at its present height, till such time as the low-water channel will take a straight course into the sea in the same direction as the breakwater, and which in my opinion will not be till the end of the breakwater comes as near the sea line of low-water as the last bend of the channel is, where the stream takes a southerly course into the sea. What this absolute distance may be, I am unable to state (from there being no survey or plan of this harbour in possession of the Commissioners, a deficiency which I did hope, from the strong representation relative thereto made in my former Report, would have been obviated before this time), but which distance I imagine may be about 3000 to 4000 feet from the present end of the breakwater.

Now taking the part already done to be about 1200 feet of efficient breakwater, at a cost of 3100*l.*, it would, by the rule of proportion, cost 10,333*l.*, in the nearest round number, to complete 4000 feet; and which at an expenditure of 1000*l.* per annum, would complete the work to that extent in the eleventh year from the time of its commencement, or, in other words, 1000*l.* per annum would serve to add about 388 feet yearly to the breakwater, more or less, according to circumstances.

I mention the sum of 1000*l.* per annum, from having understood that about that sum will probably be available for harbour improvements, after defraying current expenses; but that, or even a smaller sum, uniformly and properly expended, will, at no distant date, prove the utility and efficiency of an eastern breakwater, for preserving a direct low-water entrance channel across the sands of Rye Bay to the harbour, so that the latter may be accessible from the sea during the night, by a single pair of leading lights.

With regard to other and minor improvements in the harbour, its channels, quays, &c., many might be suggested, but without a plan to lay them down upon, it is almost useless to enter upon the subject, inasmuch as no written directions for works of this kind, without a plan, can be understood in their details. I can only therefore recommend generally, that if the means offer an opportunity, it would be advisable to deepen the Dandy Channel to the level of low water, and then stop the channel by Stag's Hole, at or near its upper end, by which means the ebb stream (as well as the flood) would take that course, and the navigation be very much improved; besides which, a more effectual scour would obtain, and any accumulation of beach be prevented at the mouth of and inside the harbour.

Many other improvements might also be gradually made in the river channel, both at and below the town, particularly in the very inconvenient bend near Brede Sluice, and again at the mouth of the old river channel below, all which should be marked down with definite lines and dimensions, on a good plan and could then at any future time be gradually carried out, as the wants and means of the harbour might require or afford.

Having thus touched upon the principal points connected with the improvement of this port, I may perhaps be allowed in connexion therewith, to make a few observations as to the best mode of carrying such improvements into effect.

Hitherto it has been the custom (as I am given to understand) for individual Commissioners or members of a Committee to undertake the direction and management of the harbour works, or certain portions thereof, according to his or their notions; sometimes by erecting works west of the harbour entrance, and sometimes east, as the case might be.

Now this mode of proceeding is in my judgment extremely represhenible, it is unbusinesslike, it tends to promote animosities between individual members of the Commission, who may each be actuated by equally priseworthy and honest motives in advocating his favorite plan; it tends also to the waste and misapplication of the funds, without fixing any proper responsibility, and is moreover below the dignity of such an important Commission, to have their works carried on in such an unusual manner.

I therefore take the liberty of most strongly recommending the Commissioners, as a first and most effectual step to their improvement, to have the whole of the executive part of their proceedings put upon a better system, by laying down a fixed plan of improvements, and appointing a responsible officer as resident engineer (or expenditor, as I believe the local term is), to see to carrying the harbour works of all kinds into effect, who should receive his instruction from, and be accountable to, the body of Commissioners only, or a committee of works to be by them appointed, and over whom no individual Commissioner should have any controul, or of the works under his charge; by pursuing such a plan as this, under proper rules and regulations, I have no doubt unanimity would prevail, money be saved, the improvements be expedited, and the town and port of Rye, together with the sewage draining out through the same, be all greatly benefited; and also, that within the short space of from seven to ten years, there may be a direct channel from the sea into Rye Harbour, and a very much improved navigation up to the quays, and town of Rye.

W. Cubitt.

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Extract from Mr. John Rennie's Evidence before the Rochester Bridge Committee in 1820.

Q. Then would not any obstruction, such as a weir or a dam across the river, have a tendency to prevent that injury at that part of the river where such weir or dam is placed?—Quite the reverse (if it is a tide river), for although it obstructs the water in running down from the interior of the country, yet it obstructs the tide-water from flowing up; and by obstructing the tide-water from flowing up, it prevents that continual scour which takes place by the flowing and ebbing of the tide. I can give the Committee a very strong fact to prove the truth of this observation; it happened about twelve or fourteen years ago, that I was employed to take a survey of the harbour of Rye in Sussex; that survey showed a very small depth of water from the sea up to a place called Scot's Float Sluice, which acted as a dam or weir to prevent the tide-water from flowing up. During the winter after that survey was taken, the sluice being in a very indifferent state of repair, was blown up by a land-fresh, and the tide of course was admitted to flow up the country as far as the level would admit. I was employed the year following to survey the same river again, and I found that during the winter in which the sluice was carried away, the river deepened nearly three feet.

"Rye Harbour has been ruined by embankments. It appears in evidence in a law suit, 1837 (Lewis Duke of Newcastle and other Commissioners of Sewers *v.* the Commissioners of Rye Harbour, for cutting and removing a bank or weir), that formerly a 64-gun ship could use that harbour which is now ruined."

Chatham Dock, 20th January, 1818.

Extracts from the Report of Mr. Rennie, to the Commissioners for revising the civil affairs of the Navy, 14th May, 1807:—

"I hold it to be a received opinion, that of the many causes which concur in the deterioration of rivers, the two following are the most prominent, viz—

"First, Embankment of marhes, stopping of creeks, and all encroachments on the space over which the tide has formerly flowed, for, by diminishing the space to be filled in any given time, (which,

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in this case, is the time of the flowing of the tide,) a proportionate diminution in velocity will ensue, and in the effect of the current in carrying off every sort of alluvial and other matters.

"The second cause to which I allude, is the contraction of the breadth of the principal channel, by partial dams, or by bridges built on starlings, similar to those of London and Rochester."

"*London, February* 24, 1801.

"The first plain and abstract question, 'whether the embanking salt marshes, overflowed by the tides and discharging their waters through a harbour, may be prejudicial to such harbour?' we feel no difficulty in answering. We consider that the magnitude of every tide harbour, both as to width and depth, is generally proportionate to the quantity of such flowing and reflowing water; and every subtraction from such quantity by embankment, tends to decrease the magnitude of the outlet to the harbour, and applied to the case in question, though a considerable quantity of fresh water flows through the harbour of Rye, it bears but a small proportion, especially in summer, to the quantity of salt water.

"That the giving up the marshes for embankment will be giving up a great natural agent, which, with other aids, might be made greatly to improve the harbour; that any other aids, without this agent, will only operate to keep it in good repair as a smaller harbour."

"JOHN RENNIE.
—— JESSUP."

No. 35.

No. 35.

Mr. Airy on Wexford Harbour.

In stating to the Tidal Harbours Commission my opinion regarding the measures proper for the improvement of Wexford Harbour, I think it right to state the sources of my information upon the condition of that harbour. I have no personal acquaintance with Wexford, but I have carefully read the Reports of Sir John Rennie, (1831), Mr. M'Call, (1837), Mr. Cubitt, (1838), Captain Vetch, (1841), and Mr. Rendel, (1844), as well as Captain Frazer's letter, (1845). But above all, I have diligently studied Captain Frazer's admirable chart, (1843). I have no doubt that, after examination of these documents, and careful reflection upon them, I am much better acquainted with the state of the harbour than I possibly could have been from any personal inspection.

It is not my intention to criticise in order the Reports to which I have alluded. I shall have occasion, however, to remark specially upon Mr. M'Call's proposal, and generally upon the recommendations which appear in some other Reports.

Referring, then, generally to Captain Frazer's chart, I shall proceed to notice the most remarkable circumstances of Wexford Harbour.

The first extraordinary circumstance is the relation of the extent of the harbour to the width of its entrance. The length of the basin, north and south, exceeds 8 miles; the average breadth (including in our estimation of extent the smaller basin above the town of Wexford) is perhaps nearly 3 miles. The whole tidal surface is, therefore, about 24 square miles, and the whole of this is filled and emptied at the same tide. The width of the entrance is less than half a mile. Consequently, the discharge is the same as if there were a river of the same width as the entrance, but 50 miles long, to be filled and emptied at every tide.

I think it probable, that in no other harbour in the world is the "equivalent channel" so long as in this. The rise of water in spring tides is about 6 feet. If, then, the average depth at the entrance were 12 feet, the length of the column of water to be run out in 6 hours would be 25 miles, implying a maximum velocity of about 6 miles per hour. It is evident that this is sufficient to tear up the bottom at the entrance of the harbour very rapidly, (unless it were rocky; it is, in fact, clay and gravel), and to increase the depth enormously, until it becomes so great, that from the increase of section thus produced the current will be less rapid.

The second extraordinary circumstance is the relation of the depths of water, at and near to the entrance of the harbour. In the channels within the harbour, the depth (at low water) is 6 to 9 feet. In the narrowest part of the entrance it suddenly deepens to 50 feet, and then immediately on the outside it shoals again, till, (I believe) in no place whatever is there a passage with more than 8 feet depth. This state of bar continues for half a mile or a mile, (to different distances in different directions), and the depth then gradually approximates to that of the neighbouring sea, north and south of the harbour.

The connexion between the second circumstance and the first is obvious. The enormous tidal current has scooped out the entrance of the harbour to a great depth, and the matter thus disturbed has deposited itself on the bottom of the sea at the smallest distance at which the motion of the water was sufficiently slow to allow it to rest. The effect of the tidal current has been precisely the same as if a dredging machine had been employed to dredge the entrance very deep, and to discharge all the matter so raised within a mile of the entrance.

It fortunately happens that the form of the Wexford Basin enables us to illustrate this action in various degrees. Above the town of Wexford there is a small tidal basin, with a surface of about 2 square miles. The channels in this small basin are 12 to 18 feet deep; the depth at the entrance of this small basin (opposite Wexford) is 19 to 26 feet; below Wexford, at the same distance from the entrance of this small basin as the distance of the exterior bar from the entrance of the great basin, it becomes 10 feet; and afterwards 5 or 6, in the centre of the wide expanse of the harbour. It is evident, here, that the small basin has produced an effect analogous in kind to that of the great basin, but smaller in degree; it has not scooped its entrance so deep, and has not deposited the matter so heavily immediately beyond that entrance.

Some of the engineers, in the Reports to which I have referred, have recommended, with a view to the improvement of the passage over the exterior bar, that the currents of the ebb from the great basin should be so directed as to act with even greater force at the entrance than they do at present. As regards this special instance, I have only to remark, that this amounts to the same as recommending that, when one dredging machine is found to be impeding the approach, by deepening the entrance and depositing the raised matter all round the entrance, another dredging machine should be placed,

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so as to double the injurious effect of the first. But, as regards the effect of such tidal currents in general, I think it proper to express my opinion, that a great mistake has frequently been committed by engineers, in supposing that a rapid efflux is necessarily beneficial to the entrance of a harbour. When the entrance is narrow, the action of the sea always tends to spread the sand and shingle across it, so as to form a line continuous with the bank on both sides of the entrance; and, to keep that entrance clear for navigation, it is indispensable to have such an efflux as will be capable of bursting through such a line of sand or shingle. But in such instances as that of Wexford we have an efflux probably 50 times as great as is necessary for that purpose, and the effect of such a great efflux, as I have said above, is purely injurious.

I conceive, therefore, that it is perfectly certain that the first great step to the improvement of the entrance of Wexford Harbour must be *the contraction of the tidal surface of the great basin.* I cannot say how much ought to be left; but I should suppose that if four square miles were left, in addition to the smaller basin, that extent would be amply sufficient for keeping the entrance deep, without raising a bar on the outside.

Supposing this determined on, the next consideration would be, what steps should be taken to secure a deep channel outside the entrance? Should a channel be dredged from the present entrance through the bar? or should a new entrance be cut from the large basin into the deeper water north or south of the bar, the contracting works of the basin being directed accordingly? And if the latter, where ought the new entrance to be?

I imagine that the cross tide would very soon fill up any channel which should be cut through the bar. I shall therefore proceed to the consideration of an alteration of the entrance; and first, I shall remark on the plan proposed by Mr. M'Call.

Mr. M'Call's plan, as I understand it, was to cut a channel from the town of Wexford, nearly straight, in a south-easterly direction, through the mud of the great basin, and through the cliffs, to the bay south of the bar. As regards the inclosure of a great proportion of the basin, and the forming a new entrance in a part that appears liable to no objection on the score of external approach, I assent entirely to the general principle of this plan. But there is one objection to it which has not been remarked by the engineers who have commented upon it, but which, nevertheless, is, in my judgment, indisputable. The proposed new channel would make such an angle with the channel which passes the quays of Wexford, that Wexford would be left upon a point of land with the channel bending round it. The consequence of this would infallibly be, that the whole scouring power of the channel would be turned upon the opposite or concave side of the channel, and the quays at Wexford would very soon be blocked up with mud. (A similar injury has been produced at Lynn, by the change of a river channel). This would be an evil so serious, that I conceive that Mr. M'Call's plan must, on that ground, be at once laid aside.

Considering it, then, absolutely necessary, for the interests of the quays at Wexford, that the existing bend of the channel to the east, immediately after passing Wexford, be preserved, I imagine that the only feasible plan which can be proposed is the following:—The eastern reach of the channel extending from Wexford is to be preserved in its present form, and the north-eastern reach which follows it is also to be preserved and to be continued a little way till it reaches the angle of Big Island. Here the channel, instead of turning to the south-east, as at present, is to be turned to the east, and, passing close to the Breast Island and Little Breast Island, is to be carried through the burrows into the sea. It would be preferable, if possible, to carry the channel a little farther north than I have mentioned; and if there is no difficulty in removing the small islands, it would be best to carry the channel through the place where these islands at present stand. The old entrance must be stopped, and all parts of the basin not specified above must be embanked.

The channel would thus enter into much deeper water than that of the South Bay, to which Mr. M'Call's proposed channel leads.

The course of the sea-tides exterior to the harbour and bar appears to be what I believe is usually called "tide-and-half-tide." And the effect appears to be, what may be anticipated in such circumstances, that there is no decided tendency to incline the mouth of the entrance-channel either to the north or to the south. I expect, therefore, that a new entrance would nearly retain the position that should be given to it, without any particular tendency to incline the direction of its mouth.

The works for the plan which I have proposed would be much less than those for Mr. M'Call's plan. But whether their expense would be too great to admit of their practicability I am entirely unable to judge.

G. B. AIRY.

Royal Observatory, Greenwich,
21st July, 1845.

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A SUMMARY of the ANNUAL INCOME of the various Ports of the United Kingdom, as derived from the Returns to the Order of the House of Commons, in compliance with the Address to the Throne of the 29th July, 1844. (Mr. *Hume.*)

England	£525,000	(approximate)
Scotland	176,000	
Ireland	93,000	
Total . . .	£794,000	

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The following works have been presented to the Commission:—

Mr. Meryon. . . .	On the Port of Rye.
Mr. D. Stevenson, C.E.	On an Instrument to measure the Force of a Wave.
Mr. Scott Russell, C.E.	Report on Waves, read to the British Association in 1844.
Mr. Stead	Book of Engineers' Reports, and others, on Harbours.

No. 38.

Report on the Quantity of Silt held in suspension by the stream in Dover Bay in February, 1845.

SIR, *Dover*, 1st *March*, 1845.

IN obedience to their Lordships' directions of the 4th ultimo, to proceed to Dover and make experiments on the deposit of silt, &c., and to report the result of my observations with as little delay as possible, I have now the honour to enclose a Journal recording, in a tabular form, the observations made on this subject during the past month of February.

These observations have been made at all times of tide, and in the various states of wind and weather, and generally in the fair stream of the channel tide at about three-quarters of a mile off shore —that is in the line of the southern breakwater of the harbour proposed by the Harbour of Refuge Commission of 1844, as shown in the accompanying chart of Dover Bay.

A few samples of water have also been taken from Dover Inner Harbour; from Folkestone to the west, and from Ramsgate to the east.

For the sake of more ready comparison, I have reduced the results to the proportion of the number of grains of silt suspended in a cubic foot of water; and which may be seen on inspection by merely running the eye down the last column of the annexed Journal. The experiments were generally made upon upwards of two gallons of water.

The *maximum* quantity of suspended matter in Dover Bay was found at high water spring tides, in a strong off-shore wind at N.N.W., when as much as 473 grains per cubic foot of water were carried along by a tide stream running at the rate of 2½ knots an hour.

The *minimum* quantity observed was on a calm day, at slack-water, when 11 grains only were found.

The average quantity of matter borne by the stream, if we include the extreme cases, amounts to 51½ grains; and rejecting the extreme cases (which I have no doubt is nearer the truth) to $33\frac{8}{15}$ths per cubic foot.

Yet there is no permanent deposit in Dover Bay; it is manifest, therefore, that if any take place, the returning stream carries it away.

In the event of a close harbour, with only one entrance, being constructed in Dover Bay, we may imagine it to fill and empty, with the tide, like a basin; the upper portion of the water, or all within the range of tide, would be changed twice in the 24 hours, or, more correctly, 704 times in a year. Now, the mean range of tide here is 15 feet and if we suppose the whole of the water brought in to bear the average amount of silt, and the whole to be deposited (which is an extreme case) the quantity, at 51½ grains per cubic foot, would amount to 77½ lbs., or, at $33\frac{8}{15}$ grains to 51 lbs. per annum on each square foot of surface. A cubic foot of silt, we find from experiment, weighs 103 lbs., the former quantity, therefore, would be equal to 9 inches, the latter to 6 inches in depth of solid deposit annually over the whole surface.

From the known nature of fluids we cannot suppose water heavily charged with silt to remain outside a close harbour, and not press to diffuse itself throughout the mass of lighter water within, and as at all times there would be a column of 45 feet, or three times the depth of the tide, (in addition to the tide itself at high water,) thus pressing for entrance, the further deposit from this cause must not be overlooked, although I am not prepared to say that it would be anything of importance.

Although this amount of suspended matter seems large, there is reason to believe that an equal or greater quantity will be found along the whole of this coast.

In Ramsgate Harbour, to the eastward, with an area of 42 acres, the deposit is 2 feet in depth a year; at Folkestone, to the west, with an area of 14 acres, it is the same. In Dover Harbour, with an area of 28 acres, there is every reason to believe it is quite as much. This is, perhaps, not more than might have been expected in small artificial close harbours, where fully one-half of the matter brought in by each tide is deposited; nor, indeed, are these extreme cases; at Hull the deposit at the entrance of the docks is, I am told, as much as 7 feet in depth a year, and at Liverpool and Bristol probably even more.

But the most remarkable increase of sand on this coast is in Dungeness East Bay. There the "Roar," or "Newcome Sand" has extended considerably towards the Ness; the low water mark has moved outwards over a space one-seventh of a mile average breadth, by upwards of 3 miles in length, during the last 35 years;* where in 1809 were 2 fathoms water, we have found *dry sand;* and where the chart of 1809 gives 10 *fathoms*, we have found 10 *feet;* but omitting for the present all calculations, based merely on the shoaling of the water, we have (in addition to nearly as much shingle) an increase of 430 acres of *dry sand*, averaging 2½ yards in depth, equal to a mass of 5 million cubic yards, or 7 million tons of deposit in 35 years; and this without any artificial construction.

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* It appears that since the erection of Dungeness Lighthouse in 1792,† the Ness has advanced seaward about 121 yards; or, at the rate of 7 feet a-year. This would hardly seem sufficient to account for the great increase of sand in the East Bay. Since the date of the former survey in 1809, the "Swallow Bank," which lies about 2 miles off shore in the East Bay has materially decreased.

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† Dungeness Lighthouse was rebuilt in 1792, at 600 yards nearer the shore than its old site, and, as we learn from an inscription in the lighthouse, at 100 yards distance from the sea (whether at high or low water is not stated, but we will assume the latter). The date of the erection of the old building is not known; but, from Jeake's Charter of the Cinque Ports, written in 1678 (page 124), it is conjectured that it was built in the time of James the First—say 1603. Supposing that the old lighthouse was erected at the same distance from the sea as the present one, that is, 100 yards, it would give us 7 feet 10 inches as the annual rate of increase of the point during 190 years.

Now, from actual survey of Dungeness Point made in Her Majesty's ship "Blazer," in November, 1844, we find that the distance from the centre of the lighthouse to low-water mark of ordinary spring tides is 221 yards; consequently, if, as stated above, the present lighthouse was built in 1792, at 100 yards from the sea, it is manifest that the Ness has advanced seaward 121 yards, or at the rate of 7 feet a-year for the last 52 years. This is certainly a remarkable coincidence.

The distance from the beach to the present limit of shingle, in going northwards towards Lydd, the nearest town, is about 5800 yards; and supposing the shingle to have increased rather more rapidly at first, or at an average rate of 3 yards a-year, this distance will carry us back 1900 years; or, speaking generally, we may imagine the sea to have bathed the foot of the present limit of verdure about the commencement of the Christian era.

With respect to the *rate* of stream that will bear a certain quantity of matter in suspension, it is not easy to try any experiments below the surface, for want of proper instruments. It appears from the enclosed journal that a stream of 2½ knots held the largest amount of silt yet taken up, namely 473 grains per cubic foot, in suspension,—but we find also that a tide stream of half a knot carried 30 grains (the average amount) in suspension; and even at slack water on the surface, in a calm, we found from 20 to 30 grains suspended in a cubic foot of water; there was, probably, however, an under current in motion.

Hitherto I have found no means of measuring these sub-marine currents, which certainly exist, and differ from the surface current. Neither Massey's Patent Log, nor Clément's *Sillomêtre* are sensitive enough; Woltmann's "Hydrometric Fly" or Tachometer (used to measure the velocity of the Danube) seems the most likely instrument to accomplish it. I believe that such an instrument has been successfully used by the Messrs. Stevenson, C.E., on rivers in Scotland; by Raucourt, in measuring the velocity of the Neva near St. Petersburg, at a depth of 60 feet; by Defontaine, on the Rhine, and by Funk, in several rivers in Germany, but the only one, which, through the kindness of Mr. Turnbull, C.E., I have been able to obtain, was out of order. I have heard, also, of a recent modification of this instrument by M. Aimé, of Algiers, now at Paris, and have written for an account of it. I purpose also trying a series of loaded floats to swim at each fathom depth, with a fine wire leading to the surface; but such observations require much better weather than the late inclement season, during which my experiments have been carried on.

I should have stated that, from an analysis by Mr. Phillips, of the Museum of Economic Geology, the silt at Dover is composed one half of fine sand, quarter of chalk, and quarter of vegetable matter.

With respect to the time required to deposit, further experiments are necessary; but from some trials in tall glass jars, I found that in still water fully one half of the particles (all the sand) dropped to the bottom in a few seconds.

May I add a few words on shingle? From observations I have been enabled to make recently on the travelling of shingle, there seems good reason to believe that if its progress cannot be entirely arrested, at any rate it can be carried off into deep water, and so fall harmless. At Folkestone, since Mr. Turnbull, the resident engineer, has run out a groyne into 8 feet water, no shingle has come into the harbour. Since the explosion by Mr. Cubitt at Round Down Cliff, the passage of the shingle has been so completely arrested, that the works near the Dover Terminus of the South-Eastern Railway are in danger for want of the usual supply; and the resident engineer has been compelled to protect them by a series of long and costly groynes.

I do not recollect any instance in which I have found shingle below low-water mark; I am aware that many differ from me in this opinion, and the subject is well worthy of careful investigation. Even at 50 yards only from the steep beach off the pitch of Dungeness our anchor, armed with a dredge or scoop, only brought up mud. Nor am I aware of any instance of shingle having crept round a groyne the outer end of which was maintained in 6 feet depth of water. If this be the case, shingle may be arrested when we please.

In conclusion, I may, perhaps, be permitted to say, that nothing has arisen in the course of these experiments to cause any doubt in my mind as to the eligibility of Dover Bay for the construction of a large harbour of refuge and defence. Whether the plan of a close harbour, with a large southern entrance, as proposed by the Harbour Commission of last year, be adopted, (and the non-deposit of silt in Kingstown Harbour, in Dublin Bay, is much in favour of such a plan,) or, if it be preferred, to endeavour to keep a current through the harbour, and thus prevent deposit; in either case I should not fear the result. Give but the eastern and western piers a fair slant with the set of the tide stream, and carry them out into the deep water, which is close at hand; let our most eminent engineers consult as to the best mode of constructing the outer parts of those piers, either on arches, or in detached masses, or in some manner, (if such be thought desirable,) so as to ensure a stream of not less than a knot an hour, throughout the harbour, and there will be little to fear either from shingle or silt; which two evils it must never be forgotten are *not* peculiar to Dover alone, but are common to, and equal in amount at, Dungeness, and every part of the south-eastern coast of England.

I am, &c.,

(Signed) JOHN WASHINGTON, *Captain.*

To the Secretary of the Admiralty.

P.S.—I am indebted to Lieut.-Col. Colquhoun, of the Royal Artillery, for much useful advice in conducting these experiments. Also to Captain Peat, R.N., of the Coast Guard, and to the Commanders of the Revenue Cruisers; to Captain Mercer, R.N., and the officers of the Packet Service generally; to Captain Martin, Harbour Master at Ramsgate, Lieut. Worthington, R.N., Lieut. Radcliffe, R.A., and Mr. G. Turnbull, Resident Civil Engineer; but especially to Lieut. Chestney Simmons, R.N., who in addition to his coast guard duties, has devoted the greater part of every day during the past month in assisting me with much zeal and intelligence.

SILT JOURNAL.

No. of the Observation.	Date. 1845	Wind		Weather, and State of Sea.	Time of High Water.		At which Sample of Water was taken up.									Quantity of Water examined, in Cubic Inches.	Matter Suspended, in Grains.	Proportion of Silt, per Cubic Foot, in Grains.	Remarks, &c.
		Direction.	Force.		A.M.	P.M.	Hour of the Day or Night.		Time of Tide.	Tide Stream at Surface.		Soundings, in fathoms, at Low Water.	Depth below Surface, in Feet.	Height above Ground, in Feet.	Locality.				
							A.M.	P.M.		Direction.	Rate.								
					H. M.	H. M.	H. M.	H. M.			Knots.								
1	Feb. 3	W.S.W.	7	Fresh breeze and much swell	7 41	8 1		1 0	⅛ ebb . .	S.W.	1	8	20	34	Dover Bay .	136½	1·5	16 7	
2	4	N.E.	8	,, ,,	8 39	9 11	11 48		⅛ ebb . .	N.E.	½	7	18	30	,, . .	136½	3·0	37 4	The water was taken up just within the line of the Southern Breakwater proposed by the Harbour Commission of 1844 in the fair stream of the channel tide at about ⅛ of a mile off shore.
3	4	S.W.	7	,, ,,	9 41	10 10		Noon, 0 0	,, . .	,,	1	6	8	26	,, . .	128½	2·0	24·0	
4	5	,,	7	,, ,,	,,	,,			,, . .	,,	1	6	Surface.	44	,, . .	128¼	2·5	31·2	
5	6	N	7	,, ,,	10 36	11 1	11 45		⅛ ebb . .	,,	1½	7	16	26	,, . .	136¼	4·7	58·4	
6	6	,,	7	,, ,,	,,	,,	11 50		,, . .	,,	1½	7	Surface.	44	,, . .	138½	10·0	135 0	
7	7	N.N.W	7	,, ,,	,,	,,	11 20		,, . .	,,	2½	5	0	40	,, . .				
8	7	,,	7	,, ,,	12 30	11 50	11 30		High water	,,	2½	6	20	34	,, . .				1728 cubic inches = 1 cubic foot. 6¼ gallons = 1 cubic foot.
9	8	S.E.	6	,, ,,	,,	,,			,,	,,	3	6	0	42	,, . .	138½	38·1	473 4	
10	8	,,	6	,, ,,	,,	0 12		Noon, 0 2	,,	,,	3	6	20	26	,, . .	138½	26·0	310·0	Specific gravity of this water 1026·05, at a temperature of 60° Fah. from several experiments.
11	10	S.W.	7	Heavy swell and sea.	0 12	2 29	11 30		⅛ flood . .	Slack	water.	2	Surface.	13	In the bight of the bay	565	7·5 26·0	93·0 85·0	
12	14	N	5	Fine weather—slight swell	3 51	4 21		0 30	,, . .	,,	,,	8½	,,	24	,, ,,	..			
13	14	,,	8	,, ,,	,,	,,	,,	0 45	⅛ flood .	S.W.	1½	7	,,	44	On line of Southern Breakwater	335	9·15	41·0	
14	14	,,	5	,, ,,	,,	,,		1 0	,, . .	,,	1½	7	42	8	,, ,,	172½	5 75	56 6	Rise of tide, 19 feet on springs ,, 11 feet on neaps
15	14	,,	4	,, ,,	,,	,,		0 40	⅛ ebb . .	N.E.	1½	7	Surface.	14	,, ,,	359	6 75	32 50	
16	14	,,	0	,, ,,	,,	,,		0 0	,, . .	,,	1½	7	16	36	,, ,,	368	16 0	45 0	
17	20	N.E.	3	Fine weather at close of a strong N.E. wind	9 58	10 20	11 15		,, . .	,,	1¼	Dry .	Surface.	16	In Dover Outer Harbour	675	2·50	8·94	The stream of tide runs for 4 hours to the N.E. after it is high water at Dover Pier, and vice versâ.
18	20	,,	0	,, ,,	,,	,,													
19	20	Calm.	3	,, ,,	,,	,,	11 20		,, . .	,,	1½	,, .	14	1	,, ,,	735	16·39	95·07	
20	20	,,	3	,, ,,	,,	,,		Noon 0 0	⅛ ebb . .	,,	½	7	Surface.	24	Dover Bay . .	667	10·0	41·48	
21	20	,,	3	,, ,,	,,	,,		3 0	,, . .	,,	1	7	42	12	,, . .	346	9·25	45·33	
22	20	,,	0	,, ,,	,,	,,		3 25	⅛ ebb . .	S.W.	1	7	Surface.	46	,, . .	533	3·50	10·47	
23	20	,,	2	,, ,,	,,	,,	,,	0 23	,, . .	,,	1	7	0	42	,, . .	554	6·0	25·0	
24	20	,,	0	,, ,,	,,	,,	,,	2 20	,, . .	,,	1	7	12	30	,, . .	673	10·0	30·10	
25	20	,,	2	,, ,,	,,	,,	,,	3 10	,, . .	,,	1	7	18	20	,, . .	663	14·75	56·58	The rate of the tide— On springs . . 2½ miles, On neaps . . 2 miles, and it sets fairly along shore, both on the flood and on the ebb.
26	20	,,	2	,, ,,	,,	,,	,,	3 14	,, . .	,,	1	7	24	24	,, . .	527	11·0	30·07	
27	20	,,	3	,, ,,	,,	,,	,,	0 10	,, . .	,,	1	7	30	18	,, . .	540	11·60	67·35	
28	21	S.W.	3	Moderate sea from smooth water.	10 37	10 56	11 48		,, . .	,,	1	7	36	12	,, . .	616	19·00	50·63	
29	21	,,	2						⅛ ebb . .	N.E.	1	Dry .	Surface.	16	Dover Harbour	602	5·6	30·00	
30	21	,,	3	A slight swell	10 57			0 30	⅛ ebb . .	,,	,,	,,			Dover Bay	614			

31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
32	[illegible]	,,	[illegible]	,,	,,	,,	,,	[illegible]	,,	,,	[illegible]	[illegible]	[illegible]	[illegible]	,,	[illegible]	[illegible]	[illegible]	
33	[illegible]	,,	[illegible]	,,	,,	,,	,,	[illegible]	,,	,,	[illegible]	[illegible]	[illegible]	[illegible]	,,	[illegible]	[illegible]	[illegible]	
34	21	,,	[illegible]	,,	,,	,,	,,		,,	,,	[illegible]	[illegible]	[illegible]	[illegible]	,,	Lost.			
35	Feb. 20	N.E.	3	Moderate and fine—sea smooth	9 58	10 20	11 15		¾ ebb			1	Surface.	20	Ramsgate Harbour	672	10 50	48·10	In outer Harbour
36	20		3									1	18	9	,, ,,	364	7 8	33·80	
37	21	W.S.W.	3	,, ,,	10 37	10 55	10 40	,,	High water.	,,	[illegible]	1	Surface.	20	,, ,,	373	6 25	48·27	
38	21		3	,, ,,						,,		1	18	0	,, ,,	337	4 5	23·08	
39	22	Calm.		Calm and fine	11 19	11 34	Noon	,,	½ ebb	,,		Dry	Surface.	12	Folkstone Harbour	368	0 0	16·22	A fresh S.S.E wind during the night.
40	22							,,		,,	½	,,	12	1	,, ,,	348	4 0	20·0	
41	23	S.S.W	1	Light winds—smooth sea.	0 30	1 10	11 15		⅛ flood			,,	Surface.	15	Dover Harbour	590	11·75	38·0	
42	25	,,	1	,, ,,	,,	,,		3 25	½ ebb			,,	,,	25	,,	636	4·0	10·60	
43	26	,,	1	,, ,,	,,	,,	11 36		⅛ flood	Slack	water	7½	,,	66	Dover Bay	677	4 25	10·85	At southern entrance of proposed harbour
44	25	,,	1	,, ,,	,,	,,		0 36				7½	19	38	,,	641	14 50	39·36	
45	26	,,	1	,, ,,	,,	,,		0 36	¼ flood	N.E.	1½	7½	42	14	,,	Lost.			
46	24	,,	1	,, ,,	,,	,,	11 40			Slack	water	7½	54	2	,,	615	10 2	26·28	
47	25	S.W.	1	Moderate breeze and slight swell.	,,	,,		3 35	⅛ ebb	N.E.	2	7½	Surface.	56	,,	509	7·30	21·81	
48	25	,,	1	,, ,,	,,	,,		5 50	,,	,,	2	7½	0	47	,,	546	12·75	34·10	
49	26	,,	1	,, ,,	,,	,,	,,	6 45	,,	,,	2	7½	18	26	,,	653	9 75	28·57	
50	25	,,	1	,, ,,	,,	,,	,,	5 43	,,	,,	0	7½	30	26	,,	649	11·0	29·83	
51	26	,,	1	,, ,,	,,	,,	,,	0 40	,,	,,	2	7½	42	14	,,	670	13·95	35·85	
52	25	,,	1	,, ,,	,,	,,	,,	3 30	,,	,,	2	7½	54	2	,,	650	14 30	38·34	
53	26	N.W.	7	Strong breeze and heavy sea.	1 27	1 46	11 50		½ flood	S.W.	½	7	Surface	40	,,	335	6·0	19·20	Strong breeze from S.W. during the past night.
54	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	10	36	,,	359	0·50	27·15	
55	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	24	26	,,	357	5 25	28·70	
56	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	30	14	,,	290	3 50	21·60	
57	26	,,	7	,, ,,	,,	,,	,,	,,	,,	,,	½	7	42	0	,,	290	5·75	30·74	
58	27	W.	1	Light winds and smooth water.	2 0	2 37	Noon.		½ flood	Slack	water.	7½	Surface.	56	,,	672	7 75	18·92	Placed a platform 8 feet square on the bottom near the south pier in the Outer Harbour.
59	27	,,	1	,, ,,	,,	,,	,,	0 0	,,	,,	,,	7½	0	8	,,	675	4·50	11·62	
60	27	,,	1	,, ,,	,,	,,	,,	0 10	,,	,,	,,	7½	10	36	,,	655	4 0	10·10	
61	27	,,	1	,, ,,	,,	,,	,,	0 10	,,	,,	,,	7½	30	26	,,	682	5·75	14·15	
62	27	,,	1	,, ,,	,,	,,	,,	0 20	,,	,,	,,	7½	42	14	,,	662	5 26	14·25	
63	27	,,	1	,, ,,	,,	,,	,,	0 25	,,	,,	,,	7½	54	2	,,	645	8·25	16·26	
64	27	,,	1	,, ,,	,,	,,	,,	0 35	,,	,,	,,	7½	Surface.	6	,,	685	13·75	34·18	
65	28	S.E.	7	Strong breeze and much swell.	2 48	3 13	0 58		Low water.	S.W	2	7	,,	44	,,	655	11·25	30·60	Strong wind rose about 11 P.M. yesterday evening.
66	28	,,	7	,, ,,	,,	,,	15 0		,,	,,	0	7	0	36	,,	643	21 8	56·70	
67	28	,,	7	,, ,,	,,	,,	20 5		,,	,,	2	7	18	26	,,	626	15 75	29·78	
68	28	,,	7	,, ,,	,,	,,	10 10		,,	,,	0	7	30	14	,,	540	16 50	33·60	
69	28	,,	7	,, ,,	,,	,,		2 0	⅛ flood			Dry	Surface.	12	Dover Harbour.	590	20 75	53·75	Between the piers.
70	28	,,	7	,, ,,	,,	,,		2 3	,,			,,	8	5	,,	615	25 26	70 94	

Dover, March 1, 1845.

JOHN WASHINGTON, *Captain.*

SILT JOURNAL.

The following Experiments were made afloat by Lieut. Chestney Simmons, R.N. :—

No. of the Observation.	Date. 1848.	Wind. Direction.	Wind. Force.	Weather, and State of Sea.	Time of High Water. A.M.	Time of High Water. P.M.	Hour of the Day or Night. A.M.	Hour of the Day or Night. P.M.	Time of Tide.	Tide Stream at Surface. Direction.	Tide Stream at Surface. Rate.	Soundings, in fathoms, at Low Water.	Depth below Surface, in Feet.	Height above Ground, in Feet.	Locality.	Quantity of Water examined in Cubic Inches.	Matter Suspended, in Grains.	Proportion of Silt per Cubic Foot, in Grains.	Remarks, &c.
77	Mar 3	E. by S.	..	Moderate breeze—sea tolerably smooth.	H. M. 8 50	H. M. 9 1	H. M. ,,	H. M.	Low water.	W.S.W	Knots 2	7½	Surface.	45	Dover Bay Long Mark. — The High Light on with a green patch in the cliff to the eastward, of a similar slope to the same.	685	5·50	13·87	
78	3	,,	.	,, ,,	,,	,,	,,	3 45 to 4 5	,,	,,	2	7¾	6	39			Lost		
79	3	,,	.	,, ,,	,,	,,	,,		,,	,,	2	7¾	12	33		685	6·50	16·39	
80	3	,,	.	,, ,,	,,	,,	,,		,,	,,	2	7½	18	27		675	8·50	21·78	
81	3	,,	.	,, ,,	,,	,,	,,		,,	,,	2	7¾	24	21		685	6·75	17·03	
82	3	,,	.	,, ,,	,,	,,	,,		,,	,,	2	7⅞	30	15		695	8·[illegible]	13·43	
83	3	,,		,, ,,	,,	,,	,,		,,	,,	2	7⅝	36	9		865	5·25	13·64	
84	Mar. 11	N	—	Strong breeze—sea agitated and rolling swell from the E.S.E., water thick and discoloured.	0 48	1 8	9 50 to 10 15	,,	Near ½ flood.	W.S.W	2	7½	Surface.	45	First Thwart Mark. —The low tree at the back of the Castle just visible, gradually dashing to St Mary's church in the low part of the valley	673	13 50	33·14	
85	11	,,	—	,, ,,	,,	,,		,,	,,	,,	2	7¼	6	39		688	18	42·13	
86	11	,,	,,	,, ,,	,,	,,		,,	,,	,,	2	7¾	12	33		660	21·25	55·52	
87	11	,,	,,	,, ,,	,,	,,		,,	,,	,,	2	7⅞	18	27		677	18·09	45·64	
88	11	,,	,,	,, ,,	,,	,,		,,	,,	,,	2	7¾	24	21		677	18·25	46·56	
89	11	,,	,,	,, ,,	,,	,,		,,	,,	,,	2	7¾	30	15		675	18	46·08	
90	11	,,	,,	,, ,,	,,	,,		,,	,,	,,	2	7½	42	3		375	10·	[illegible]	
91	12	North.	..	Fresh breeze and snow, sea in the similar state as yesterday	1 28	1 43		,,	Last ½ . .	W.S.W.	2	7½	Surface.	45	,, ,,	698	9 50	23·79	
92	12	,,		,, ,,	,,	,,	6 45 to 7 [illegible]	,,	Slack . .	,,	2	7½	6	39	,, ,,	675	14 25	36·48	
93	12	,,		,, ,,	,,	,,		,,	,, . .	,,	2	7¾	12	33	,, ,,	673	16 [illegible]	41·76	
94	12	[illegible]		,, ,,	,,	,,		,,	,, . .	,,	2	7½	18	27	,, ,,	678	18 [illegible]	46·32	
95	12	[illegible]		,,	,,	,,		[illegible]	[illegible]		2	[illegible]	24	21	,,	[illegible]	[illegible]	[illegible]	

Appendix, No. 38.

98	30	N. by W. ,,	Strong breeze—sea smooth and fine clear water.	8 37	6 3	,,		Low water.	W.S.W	2½	7½	Surface.	48	Marks as above	676	11 6	23 37
99	20	,, ,,	,, ,,	,,	,,	,,	3 20 to 3 42	Ebb ,,	,,	2½	7½	6	35	,, ,,	678	11 75	20 29
100	20	,, ,,	,, ,,	,,	,,	,,		,, ,,	,,	2½	7½	12	32	,, ,,	673	13 63	33 52
101	20	,, ,,	,, ,,	,,	,,	,,		,, ,,	,,	2¾	7½	18	27	,, ,,	665	15·0	26 97
102	20	,, ,,	,, ,,	,,	,,	,,		,, ,,	,,	2½	7½	24	21	,, ,,	672	15 0	32 37
103	20	,, ,,	,, ,,	,,	,,	,,		,, ,,	,,	2½	7½	30	10	,, ,,	652	15 33	43·07
104	20	,, ,,	,, ,,	,,	,,	,,		,, ,,	,,	2½	7½	36	11	,, ,,	649	15 35	39 75
105	Apr. 3	East. ,,	Light breeze and fine, sea very smooth	8 35	6 42	,,		Low water	W.S.W	2½	7½	Surface.	48	Marks as before.	683	7 0	17·71
106	3	,, ,,	,, ,,	,,	,,	,,	3 20 to 3 47	,,	,,	2½	8	6	41	Dover Bay ,,	658	7 5	18 83
107	3	,, ,,	,, ,,	,,	,,	,,		,,	,,	2¾	8	12	36	,, ,,	643	0·25	15·61
108	3	,, ,,	,, ,,	,,	,,	,,		,,	,,	2½	8	18	30	,, ,,	648	8 5	16 32
109	3	,, ,,	,, ,,	,,	,,	,,		,,	,,	2½	8	24	24	,, ,,	656	6 75	14 46
110	3	,, ,,	,, ,,	,,	,,	,,		,,	,,	2½	8	30	18	,, ,,	580	4 76	11 53
111	3	,, ,,	,, ,,	,,	,,	,,		,,	,,	2½	8	42	6	,, ,,	656	7 6	17 58
112	24	Calm. ,,	Cloudy—sea smooth with muddy appearance.	,,	0 22	7 20	,,	,,	,,	3	14	36	60	Dover Castle, N.N.W.	660	10 75	27 31	L and Screven, R. N.
113	24	W.S.W. ,,	Strong breeze and rain—sea rather rough.	10 21	10 46	,,	3 25	Ebb stream just making	W.S.W	Nil	7½	31	48	Foreland Upper Light, N.E. by N. Marks same as 5th March.	681	12 0	30 48	,,
114	May 21	,, ,,	,, ,,	,,	,,	,,	,,	,,	,,	,,	7½	Surface	46	,, ,,	632	2·	5 36
115	21	,, ,,	,, ,,	,,	,,	,,	,,	Ebb ,,	,,	,,	7½	6	39	Dover Bay ,,	645	5·	12 61
116	21	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	,,	7½	12	33	,, ,,	664	6·	10 40
117	21	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	,,	7½	18	27	,, ,,	662	2 5	0 53
118	21	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	,,	7½	24	21	,, ,,	655	3 25	0 57
119	21	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	,,	7½	30	15	,, ,,	670	0 5	6 37
120	21	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	,,	7½	42	6	,, ,,	666	4·8	10 37
121	June 1	Calm. ,,	Weather fine—sea perfectly smooth.	8 10	8 20	,,	3 0	Low water.	W.S.W	,,	7½	Surface.	48	Same marks	675	1 75	5 25
122	6	,, ,,	,, ,,	,,	,,	,,	,,	Ebb ,,	,,	1	7½	6	39	,, ,,	576	1·5	4·6
123	6	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	1	7½	12	33	,, ,,	575	1 5	4 5
124	6	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	1	7½	18	21	,, ,,	576	3·75	10·25
125	6	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	1	7½	24	15	,, ,,	574	1 5	4·5
126	6	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	1	7½	30	4	,, ,,	580	2 0	4 0
127	6	,, ,,	,, ,,	,,	,,	,,	,,	,, ,,	,,	1	7½	42	3	,, ,,	576	0 23	4 75
128	6	S.S.W.	Moderate breeze and fine—sea rather rough and swell from S.S.W	11 32	,,	,,	,,	Slack water between half and quarter ebb	W.S.W	1	7½	Surface.	48	,, ,,	570	3 75	11·25
129	,,	,, ,,	,, ,,	,,	,,	,,	3 42 to 4 6	,,	,,	1	8	12	36	,, ,,	576	5·75	17 53
130	,,	,, ,,	,, ,,	,,	,,	,,		,,	,,	1	8	18	30	,, ,,	570	4·75	14 20
131	,,	,, ,,	,, ,,	,,	,,	,,		,,	,,	1	8	30	16	,, ,,	578	5 0	15·0
132	,,	,, ,,	,, ,,	,,	,,	,,		,,	,,	1	8	36	12	,, ,,	576	6 5	19 5
133	,,	,, ,,	,, ,,	,,	,,	,,		,,	,,	1	8	42	6	,, ,,	576	Lost	
134	,,	,, ,,	,, ,,	,,	,,	,,		,,	,,	1	8	48	6	,, ,,	576	6 0	16·0

SILT JOURNAL—*continued.*

No. of the Observation.	Date. — 1845	Wind.		Weather, and State of Sea.	Time of High Water		At which Sample of Water was taken up.									Quantity of Water examined, in Cubic Inches	Matter Suspended, in Grains	Proportion of Silt per Cubic Foot, in Grains.	Remarks, &c.
		Direction	Force.		A.M.	P.M.	Hour of the Day or Night.		Time of Tide.	Tide Stream at Surface.		Soundings, in fathoms at Low Water	Depth below Surface in Feet.	Height above Ground, in Feet.	Locality				
							A.M.	P.M.		Direction.	Rate.								
					H. M.	H. M.	H. M.	H. M.			Knots								
135	26	North	..	Moderate breeze and fine weather — swell from Eastward.	5 0	5 50	„	0 25 to 0 50	Near half flood	W.S.W	½	7½	Surface.	45	Dover Bay, marks as before.	576	5 5	20 5	Water very clear; saw the bottle at the depth of 18 feet.
136	26	„	..	„ „	„	„	„		„	„	½	7½	0	39	„ „	576	1 5	4 5	
137	26	„	..	„ „	„	„	„		„	„	½	7½	12	33	„ „	576	1·5	4 5	
138	26	„	..	„ „	„	„	„		„	„	½	7½	18	27	„ „	576	1·5	4 5	
139	26	„	..	„ „	„	„	„		„	„	½	7½	24	31	„ „	576	1 5	4 5	
140	26	„	..	„ „	„	„	„		„	„	½	7½	30	15	„ „	576	1 75	5 25	
141	26	„	..	„ „	„	„	„		„	„	½	7½	42	3	„ „	576	2 0	6 0	
142	26	„	..	Light breeze and fine weather—swell from the S.W.	3 47	4 10		„	One hour past low water	„	1	7	Surface.	42	Dover Bay, marks as before.	576	4 25	12 75	Water thick, nothing visible below the surface
143	26	„	..	„ „	„	„	11 13 to 11 38	„	„	„	1	7	0	36	„ „	576	5 75	17 25	
144	26	„	..	„ „	„	„		„	„	„	1	7	12	30	„ „	576	6 0	18 0	
145	26	„	..	„ „	„	„		„	„	„	1	7	18	24	„ „	576	6 25	18 75	
146	26	„	..	„ „	„	„		„	„	„	1	7	24	18	„ „	576	7 5	22 5	
147	26	„	..	„ „	„	„		„	„	„	1	7	30	12	„ „	576	5 5	16·5	
148	26	„	..	„ „	„	„		„	„	„	1	7	36	6	„ „	576	7 0	22·5	
149	July 16	W.S.W.	..	Moderate, and fine weather	9 43	10 10	„		Last quarter ebb.	W.S.W.	1	7½	Surface.	45	Marks as above.	576	3 75	11 25	
150	16	„	..	„ „	„	„	„	3 15 to 3 45	„	„	1	7½	0	39	„ „	576	7 25	21·75	
151	16	„	..	„ „	„	„	„		„	„	1	7½	12	33	„ „	576	9 50	28 50	
152	16	„	..	„ „	„	„	„		„	„	1	7½	18	27	„ „	576	9 50	28 50	
153	16	„	..	„ „	„	„	„		„	„	1	7½	24	21	„ „	576	8 75	26 25	
154	16	„	..	„ „	„	„	„		„	„	1	7½	30	9	„ „	576	11 0	33·0	
155	16	„	..	„ „	„	„	„		„	„	1	7½	42	3	„ „	576	10·25	30·75	
156	25	E.S.E.	..	Moderate and fine—sea smooth.	3 16	3 46	„		High water	N.N.E.	2	7½	Surface.	45	„ „	576	7 0	21 0	
157	25	„	..	„ „	„	„	„	3 15 to 3 30	„	„	2	7½	6	39	„ „	576	2 50	7 50	
158	25	„	..	„ „	„	„	„		„	„	2	7½	12	33	„ „	576	3·0	9 0	
159	25	„	..	„ „	„	„	„		„	„	2	7½	18	27	„ „	576	5 0	15 0	
160	25	„	..	„ „	„	„	„		„	„	2	7½	24	21	„ „	576	5·25	15 75	
161	25	„	..	„ „	„	„	„		„	„	2	7½	30	15	„ „	576	5 50	16·50	
162	25	„	..	„ „	„	„	„		„	„	2	7½	36	6	„ „	576	4·75	14·25	

Dover, August 1, 1845.

COURTNEY SIMMONS, *Lieut. R.N.*

ANALYSIS OF EVIDENCE.

Bald, William, C. E., Resident Engineer on the Clyde, from 1839 to 1845 . . . . . p. 1
Cut a channel 100 yards wide and 6 feet deep through Port Glasgow Bank, 4——Also
through the Puddle-deep and Garmoyle Banks about 2 feet; no tendency to silt up, 20——
Deepened to 10 feet at low-water springs, 23——Gained 2½ feet depth of water at Glasgow,
by which vessels drawing 17 feet water now come up to the Quay, 29——Made cuts at
Dumbarton Bank and Long Dyke, 32——Rule to preserve a width of 100 yards at Glasgow,
and 133 at mouth of river Cart, 6 miles below Glasgow, 39——Estimates expense of
dredging the channel on south side of Newshot at 7000*l.*, 43——Recommends it to Clyde
Trustees, 46——States it to be 100 yards shorter, to contain an area of 100 acres, and if
cleared out would hold 34 millions of cubic feet of water, 46——A pier belonging to Mr.
Henderson projects 150 yards into the river west of Newshot Isle, 50——The south channel is
blocked up by a dyke, and will soon become meadow land, 51——To open it would be the
greatest improvement to the river, 61——Rate of tidal wave from Port Glasgow to Bowling,
13 miles an hour, from Bowling to Clyde Bank only 6½ miles, and from Clyde Bank to Glas-
gow 10 miles an hour, 64——Attributed to the crooked north channel, and not to difference in
depth, 65——Ordered to desist from pulling down a dyke, 77——The parallel dykes erected
by the late John Rennie, 78——Removed a weir 3 feet high at Glasgow Bridge, 91——The
weir at Stockwell-street Bridge stops considerably the flow of the tide upwards, 98——Spring
tides flow above the Glasgow Water-works to about 4¼ miles above Glasgow, 102——If weir
were removed 25 million cubic feet of tidal water would ascend 4 miles above Glasgow each
tide, 105——Weir is necessary to support bridge, 106——Weir was made by Act of Parlia-
ment to sustain the level of low-water above bridge for the benefit of the Water-works Company,
127——If removed Glasgow need not be deprived of fresh water; the weir might be placed at
Dalmarnock, 3 miles higher up at the limit of ordinary tides, 129——Need not cause damage
to manufactures, &c., 132——Salt water only reaches Renfrew 6 miles below bridge, 136——
Within the last six years has dredged about 1½ million cubic yards of stuff from bed of river,
138——The effect is great improvement in trade, 142——Present depth at Glasgow Quay at
low-water 11 feet, and bottom soft, 146——A basin of 6½ acres capable of holding 60 ships
has been proposed, 148——Owing to the porous nature of the ground there would be great
difficulty in making it a wet dock; it would be better as a tidal basin with 15 feet at low-
water, 149——Rise of tide at Glasgow Quay 6 feet 6 inches to 7 feet, 149——On the north
side of river at Stobcross is good ground for a floating dock, 149——Such a basin might be
puddled, 156——Clyde is too narrow; all the points between Glasgow and the Cart river
should be cut off, 158——During the last two years witness has added 7¼ acres to the harbour;
cut off point on north side from the Kelvin east; has given plans for cutting off at Over
Newton, Fairfield, &c., 139——Considers it highly objectionable to lay soil dredged up on the
alveus of the river, 162——The Clyde too important a river to the trade of the country to be
left solely to local powers; it should have independent and superior control, 170——The Clyde
Trust composed of 33 members, principally merchants, 172——Witness opposed the Union
Railway Company who wished to lay rails down along the quays on the north side of the har-
bour, 182——It would be injurious to the foreign trade, 182——Attributes benefit on Clyde to
dredging, 204——The oldest map of the Clyde is that of William Kyle, of Glasgow, in 1800; this
shows 219 jetties begun in 1768 by Golborne; and the former alveus of the river, and therefore
would show any present encroachments, 214——The river might be improved by removing
obstructions, 219——At present there is a great deposit of silt in Glasgow Harbour, 80,000
cubic yards annually; at Bowling, 10 miles lower down, a bank of 60,000 cubic yards rises
each year, 219——Ten feet depth of water in Newshot Isle, north channel, 224——The south
channel should be cleaned out, and would be better, 226——Would lower the parallel dikes
on the Clyde so as to be ½ and ½-tide dikes, 245——Dikes are necessary to protect the
banks of the river, but they should be so placed as not to obstruct the tidal flow, 252–3——
Depth in Glasgow Harbour solely due to dredging, 254——Freshes rise at times 15 feet above
low-water, or double a spring tide, 255——Removal of obstructions would drain the city better,
258——All the water-works and supply of water to the factories could be kept up if the weir
were removed, 259——Mr. James Walker has been consulting engineer during the time witness
has been resident engineer, but the plans have not been submitted to him, 260——Stockwell
Bridge is said to be insecure, and is to be taken down, 266——Knows no reason why the
funds of the Clyde Navigation Trust should aid in building a new bridge, 269——Strongly
objects to another weir being placed across the river, 270——The weir was first caused by
stones being thrown into the bed of river to protect old Glasgow Bridge; but not by Act of
Parliament or any public authority, 274——It was then removed to Stockwell Bridge, and it is
now proposed to remove it to 140 yards above Hutcheson's Bridge, 275——If water were taken
from 2½ miles higher up the river there would be no occasion for a weir all, 276——And this
would free the navigation up to Rutherglen, and be a great benefit, 278——In the year 1839
reported strongly in favour of the extension of the Clyde navigation upwards, 494——Quoted
the evidence of Telford and Jardine to show that if the bed of the river at Dalmarnock be
secured the weir may be taken away entirely, 496——But no attention was paid to his report,
497——Reported again in 1844 against peat being thrown into the streams Black Cart
and Gryfe, 500–1——Every auxiliary stream should be kept open, 511——Suggested the
working the dredging barges by steam, whereby 80,000 cubic yards of soil additional have
been raised a year, 515——Suggested an iron diving-bell boat in order to remove boulders
from the bed of the river, 516——In the year 1842 was ordered to desist from working the
diving bell, 516——States the works he has carried out on Clyde or Bowling Basin of 14
acres; enlargement of Glasgow Harbour 7 acres, &c., 517——Boulders of whin-stone still in
bed of Clyde, 526——Has lifted 1000 tons of boulders per year, some weighing 5 tons, 531–8

——Expense of dredging from 8*d.* to 12*d.* per cubic yard, 535——The soil is chiefly fine sand, and comes from the upper country, 541.

Witness has extended a pier at West Port; reported to Board of Works on the improvement of the rivers Boyne and Drogheda, 184——Plan published by Irish Board of Works, 189——Gave a plan also for improvement of the river Moy in west of Ireland, 194——Also planned a harbour in Tramore Bay, in south of Ireland; improvements on river Suir; and gave two plans for the improvement of Troon, 195——Opposed a dam across the river at Belfast; made plans and sections for improvement of river Foyle at Londonderry, 196——Gave evidence against the dikes near Newburgh on the Tay, 201——Local influences are prejudicial, Government should have control in all Harbour Trusts, 205–6——Landed proprietors have generally encroached, 208——Embankments to a large extent are proposed in Ireland; at Belfast 2500 acres; at Lough Swilly; and Lough Foyle, said to be 20,000 acres, 209——Has warned the Trustees of Londonderry against this encroachment, 211——Is of opinion that it would be injurious to enclose Jarrow Slake on the Tyne, 212——Is of opinion that all harbours should be under Government control, 228——Such is the system in France, where it works well, 233——The first and most useful thing would be to obtain accurate plans of all our ports, 238——It would be true economy on the part of Government to spend money on our ports, 241——Has been applied to to go to Rouen and report on the Seine, 243——As a general principle is of opinion that cutting off tributary streams or damming up creeks is objectionable, but exceptions may arise, as at Belfast, where it might be a benefit to cut a more direct channel to the sea, 546.

Stevenson, Alan, C. E., Engineer to the Northern Lights . . . . p. 13
Has viewed the Tay, Forth, Ribble, Lune, and Dee, 283——Surveyed the Tay in 1833, principal obstructions to navigation were at Kirwhinnel Ford, at the entrance of the Earn, at Seggieden Ford, at Mill Hurst, and other fords, 286——Obstructions caused by 9 jetties on the south bank of the river, accumulating large quantities of gravel and mud, 290–295——Some jetties removed by process, 297–302——Jetty at Wemys removed on remonstrance, and mud bank dredged away, 308, 309——Dykes run out near Mugdrum Island, and at Nethermain's Island (the latter 333 yards long), with a view of forming land, 320–323——City of Perth is conservator of the river, from Perth to Invergowrie Burn, 3½ miles above Dundee, 316, 317——Pier of Cairnie shortened by order of the Tay Commissioners, 331——Cairns in the middle of the stream removed, 333——Materials deposited opposite Pitfour, 334——Impede the flow of the tide to Perth, but deepen the channel at Kirwhinnel, 337, 338——In 1834, depth at Mill Hurst Ford, at high-water spring-tides, 11–9 feet, at low water, 1–9 feet; in 1845, high water, 16 feet, low water, 4–9 feet, owing to the removal of the fords; tide also reaches Perth 55 minutes sooner, 340–360——There is now a depth of 15 feet at high water all the way to Perth, 360——Tide does not rise to a higher level than formerly, but bed of river is deepened, 360——Act for deepening river from Perth to Newburgh, obtained in 1834, 344——Has reported to Tay Commissioners that by dredging 850,000 tons more, a depth of nearly 20 feet might be obtained up to Perth, 363——Endeavours of landed proprietors to encroach on the banks of this river, the Lune and Ribble, such encroachments impediments to navigation; several proprietors are Commissioners, 365——Independent Commissioners necessary for the purpose of appeal, local Commissioners sometimes at variance with public interests, 367–382——Proposals of all changes or improvements should be submitted to a public Board having conservancy of rivers, 383——A local public officer to have plans, and to report, or check encroachments, 383–388——By proper embankments and removal of obstacles, the velocity of the tide and its scouring power might be increased, 390——Occasionally portion of tidal water may be excluded with advantage, 393——Velocity of tidal wave between Newburgh and Perth previous to improvements, 3·42 miles per hour, subsequently more than 5·13 miles, 395——Lights and buoys at mouth of Tay are in charge of the Trinity House, Dundee, 400, 401——Alteration in mouth of Tay; survey taken by order of Admiralty, 402——Tay drains 2,283 square miles of country, mean discharge, 220,000 cubic feet of water per minute; Earn discharges 54 959 cubic feet per minute, 403–409——Mr. Rennie says, Thames discharges 80,000 cubic feet per minute, 410——Soil dredged up from Tay in 5 years, 841,480 tons deposited at the back of Sleepless, Mill Hurst, and Balbepburn Island, 412——Tide reaches 2½ miles above Perth, 35 miles from sea, 418——Salt water extends a little above Mugdrum Island, which is 7½ miles below Perth, and 25 from mouth of river, 423——Jetties thrown out at Powgavie and Errol very detrimental; if completed, they would exclude 1,800 acres of tidal water, 428——The longest is half a mile long, 430——Proposed railway bridge at Mugdrum, if erected, would have destroyed navigation of Tay upwards, 436——No bridge should be permitted lower than Perth, if so low, 440——No evil apprehended from swing-bridge over the Earn, 443.

Has reported on the navigation of the Ribble, 444——Began to dredge there in 1838, 446——Six feet depth of water have been gained. Ribble will admit of deepening 20 feet up to Preston, 447——There are now 14 feet up to Preston Marsh, 449——Full 31,000 cubic yards of rock have been excavated by means of coffer-dams, 452——Dredging will be carried on, and a wall completed to direct the current, 458.

Has reported on the Lune leading to Lancaster, but for want of funds no works have yet been begun, 462——Lancaster, 6 miles from the sea; and if proposed works were carried out, a depth of 16 feet at high-water spring-tide would be obtained up to this town, 464——At present there are barely 13 feet over the fords, 465——The obstacles to be removed are Seale Ford, Baffler's Ford, Heaton Shoal, Colleway Shoal, 467–474——Depth of water at Glasson Dock at mouth of river, 25½ feet, 469——Rise of tide at Glasson, 21 feet, at Lancaster, 10 feet; the bed of the river rises 11 feet in 6 miles, 479——Is not aware that the Corporation of Lancaster have enclosed several hundred acres of land at Marsh Point, 486——Estimate of expense for obtaining 16 feet at high-water spring-tides to Lancaster, 7.425*l.*; to complete further improvements in widening and deepening the river, 5,775*l.* in addition; total 13,200*l.*—*Note.*

Walker, James, C. E., Consulting Engineer to Clyde Navigation Trust, and F.R.S. . . . p. 24
The proposed weir on Clyde is to be placed on the level of low water in the river before improvements began, 590——Tide now falls out from 2 to 3 feet lower than formerly, 591——Tide flows feebly 2 miles above the proposed site for weir, 593——Depth of the Clyde at Glas-

gow does not depend upon the tide, but on the river freshes, 596——Every fresh carries away more soil than it brings down, 597——Rate of tide at Glasgow 1 mile, of a fresh 4½ miles, an hour, 599——Practically the weir in the Clyde does not impede improvements of the river, 601——Just below the weir is a gully of 15 feet depth, 602——Before the deepening of the river above bridge by the trustees, its bed was nearly dry, 602——If it could be done, is quite ready to take upon himself professionally the whole responsibility of removing the weir up to Dalmarnock, 603——By this the river near Glasgow would be materially improved; it would form a large basin, and would extend the harbour 2 miles higher up, 604, 605——If the weir were removed the river in a fresh might so scour the banks and bed, as to bring down Rutherglen Bridge, 606——Would wish anything done to increase the flow and ebb of the tide to the utmost, but the opposition would be too strong to attempt to carry such a measure now, 608——Has contemplated a plan for removing the weir, by having a pipe from Dalmarnock to the factories in the city, 614——Cranston Water-works might be united with the Glasgow Water-works, 614. If the change of channel could have been made completely from the north to the south side of Newshot Isle, it might have been desirable to do so, but under the circumstances it was wrong to begin such a work, as the weir could not keep two channels open, 642——Saw the resident engineer on that occasion, but as Rennie, Telford, and Logan, all preferred the north channel, he saw no sufficient reason to change it, 647——Since 1839, has been frequently consulted as to improvements, but not as to the mode of carrying out works, 674——Mr. Logan gave the lines of parallel dykes which have been slightly modified, 674——It would be mischievous to remove the dykes, or to widen to any great extent; Clyde has been more improved than any river in the world; in Smeaton's time, only 3 feet at high water at Glasgow Quay; but by the skill of Golborne, Rennie, and Telford, it has been brought to its present state; if Clyde had been made too wide at first, the present depth would not have been obtained, nor the consequent large revenue; by widening it now to nearly double the former width, great increase of dredging will be required, 675——Depth in upper part of river due to freshes; in the lower to tides; all the lower dykes should be half-tide dykes, 676——Considers it would be waste of money to close the channel north of Newshot Isle, and to open the south side, 683——The gain in distance would be 130 yards in 2 miles, 685——If the section of the south channel made by Mr. Aird be correct, the removal of half a mile of solid rock would cost ten times Mr. Bald's estimate, 686——There is a longitudinal section of the river from Glasgow to Greenock, 691——The removal of the weir at Glasgow Bridge has so deepened the river, that Stockwell Bridge is in danger of falling, and as the deepening is to go on, it seems fair that the river trustees should pay the additional expense, caused by founding the piers so much deeper, and by removing the weir 1100 yards higher up the stream, 694——Sir John M'Neil and witness reported that 8,100*l.* would be a fair sum to be paid for this purpose.

The Glasgow Junction Railway Company purpose to carry a line of rails across the Clyde upon two piers 15 feet wide, to be built in the middle of the river, at 16 yards below Glasgow Bridge; height of middle arch to be 35 feet above high water. The Glasgow Bridge has 6 piers, average 8½ feet wide, taking up 51 feet of the water-way, 2248——The railroad might cross quarter of a mile above Rutherglen Bridge.

Is not sure that it would be an advantage that Government should have the nomination of some of the trustees of a port. It is certainly desirable that all harbours should be improved as much as possible, to be of use in the event of war or bad weather.

Enumerates upwards of 60 harbours that he has examined and reported on; has not been able to lay down any general principles for improvements, each harbour must be treated *per se.* The upper parts of a river usually depend upon freshes, the lower part on the tidal scour. Whitby is a case which depends almost entirely upon land floods; the chief obstuctions to the propagation of the tidal wave are irregularity of width and a contracted channel. Whitby is a case where the obstruction is entirely caused by the sand which is washed in from the sea. Judiciously narrowing and improving their depth is the best mode of dealing with rivers, 2754.

In Report on Thames of 1842 states that Barking Shelf is the worst in the river, and might be removed without difficulty: considers that it is much to be deplored that so important a measure as the removal of the several shoals in the river should, for the want of 60,000*l.*, be left untouched. The Report in 1843 enumerates 14 shoal places in the river, and that all might be removed, and witness has had no reason to alter his opinion; contemplates a uniform depth of 12 feet at low-water springs from London Bridge to Gravesend; dredging may be done at from 9*d.* to 1*s.* a cubic yard. Is of opinion that there should be one superintending power over all harbours to control all operations where navigation is concerned, 2770——Considers that local trustees, with proper professional advice, are the most likely persons to be vigilant conservators of their rivers; a general surveillance would be unobjectionable on public grounds, 2775. Is of opinion that there ought to be a plan of every harbour in the United Kingdom, but would not interfere with the present efficient system of the hydrographer, in having each port surveyed. There should be efficient conservancy over the harbours, but it will require great caution as to the party entrusted with the exercise of that power, 2782——Has reported that the embankments at Southwold Harbour are an evil, but it must not be supposed that in all cases the embanking of land is an evil. The Thames, for instance, was once six times its present width, and many thousand acres of marsh land have been taken from it with advantage, reserving always an adequate breadth for a channel, 2785——The evil in Southwold Harbour arises from the tidal estuary having been diminished, so as no longer to contain backwater to scour the harbour, 2786——No reason to suppose that the shoals at the mouth of the Thames have increased, or that they will increase, 2789——If the Penryn Dock were made, does not apprehend any danger of silting up in Falmouth Harbour. It would be advisable to call upon the parties to give security for the completion of the works, or for their removal. The balance is in favour of good being done by the proposed dock rather than evil, 2806——With respect to the improvement of the Thames, is of opinion, that a Commission should be formed, in which the different interests are represented; as the City of London, the Crown Lands, the Admiralty, and the Trinity House, and they should carry out the requisite improvements, while the two former bodies are at law, regarding the right of soil; has reason to believe that this would have been done, except for the change of Ministry. In the meantime the navigation of the Thames is neglected, and its commerce interrupted, 2810.

Gray, Charles, Deputy Chairman, and **Turner, Angus**, Secretary of the Clyde Trust . . p. 24
Act under 3 and 4 Vict., c. 118, 552——Smeaton, Golborne, Rennie, and Telford have been the
engineers consulted on the Clyde, 553——Mr. J. Walker is now consulting engineer, 554——
Meeting to oppose Glasgow Junction Railway, 570——Trustees are bound to maintain the level
of the river on account of the water-works, 576——Old weir at Glasgow Bridge, the present one
at Stockwell Bridge, 579——A Bill before Parliament to move weir 1100 yards higher up the
river, 581——Could not at present be removed higher without injuring factories, 582——Water
Company and two factories are secured by statute, 586——The trustees look forward to the pos-
sibility of ultimately removing all the weirs on the river, 618——Newshot Island south channel
is straighter but rocky; would cost 8000*l.* to open; owners of property on the north side of the
river would object to the north channel being shut up, 620——Proprietors of adjoining land
claim the soil made by the dykes, 624——Clyde trustees have power to remove dykes which
injure navigation, 626——There are clauses in the Act of 1840, which recognize the right of
the land-owner to protection for his banks, 628——It may be a question whether, owing to lapse
of time, the public may not have lost its rights to the south channel, 629——By Act of 1840,
the trustees can take land, formerly the alveus of the river, on paying half its value, 631——
In recent Act the Crown claims all property within the ancient alveus of the river, 632——
The Woods and Forests have received 1,700*l.* as half price for such land since 1840, 632——
These decisions virtually prove the rights of the public to all land formerly covered with the
tidal flow, 633——The dyke in Newshot south channel is a half-tide dyke, and the Clyde
trustees did not think its removal of sufficient consequence to navigation to go to law about it
with the proprietor of the adjacent shore, 634——The resident engineer gave his opinion that
it ought to be removed, and began to do so, but the trustees, acting under the advice of their con-
sulting engineer, stopped it, 635–640——Does not consider the Clyde to have been materially
improved since Mr. Bald became its engineer, 652——Cannot speak exactly as to increased
depth, as the only soundings in the river that the trustees would be responsible for, were taken
in 1839, 637——Mr. Bald was instructed by the Committee to deepen the Port Glasgow Bank,
659——Has no knowledge of the Board having forbidden the removal of boulder, 664——It
appears from the Minute produced, that Mr Spreull, the treasurer, did issue such an order, but
he had no authority to do so, 668——Many Reports have been received from Mr. Bald, recom-
mending improvements in the upper part of the river, 670——Mr. Walker has been consulted
as to improvements within five years, but not as to the plan of carrying them out, 673——It is
proposed that the Clyde Trust shall pay 8000*l.* towards erecting the Stockwell Bridge, upon con-
dition of the piers being founded deep enough to admit of deepening Glasgow Harbour, 693——
Foundations and weir at Stockwell Bridge strengthened a few years since; it was necessary to do
so, as the Water Company complained of losing their water; and it was done by driving a row of
piles across the river, under an order of the Court of Sessions, 695.

Hinde, Richard, Robinson, William, and **Sharpe, Edmund**, Lancaster Quay Commissioners p. 33
Authorised to appear on behalf of the Commission, 699——The recently proposed bridge over
the Lune by the Lancaster and Carlisle Railway Company will cross 500 yards below the
lowest existing bridge, 702——The town quays, with a depth of 2 feet water, extend below the
proposed crossing; the bridge will be of two arches, fixed, and at a level of 32 feet above the
quays, so that rigged vessels could not pass under, 708——The railway company offer
16,500*l.* compensation for wharfs, storehouses, &c., but nothing for improving navigation, 711——
The quay will probably cost 10,000*l.*, 714——Occasionally vessels of 200 tons come up to the
quay, 727——Of the two proposed railways considers the original one above the town would
interfere least with navigation, 730——Vessels discharge at Lawson's wharf, 731——Tide
reaches ½ mile above the town to Skirton Locks, which obstruct the flow, 734——New bridge
is built on five arches, which are so low, that no vessels can pass, 736——If bridge is per-
mitted it will interfere with 500 yards of navigable harbour space, 741–743——At Scale Ford
dredging took place in the Lune some years ago, 744——Consent given to the new line by the
Quay Commissioners, on the ground of being more beneficial to the navigation, and the town
generally, 745–752——Commissioners elected triennially, 748——Two piers will stand in the
bed of the river, and occupy 24 feet of waterway, 755——Resolution at a public meeting of the
inhabitants of Lancaster in favour of the new line, 757——New quays to be erected westward
of intended viaduct, for the convenience of shipping, 760, 761——Of opinion that proposed
railway bridge will be prejudicial to flow of tide, 769——The only compensation for injury
done to the river would be by deepening the channel; length of channel 6 miles; bed of river
at bridge 10 feet above low water mark, 771——Stevenson's Report of 1838, recommending
the removal of shoals to obtain an additional depth of 4 feet in the whole course of the river,
giving a depth of 16 feet at high water spring tides at Lancaster Quay; estimate 13,200*l.*;
no funds to carry out such improvements, 777——Present greatest depth at spring tides, 12
feet; the commerce of the district requiring a depth of 20 feet at spring tides; but the expense
of such improvement would be very great, 781——From the survey taken by Capt. Denham,
it is the opinion of many of the Commissioners that the necessary improvements are unattain-
able, 783, 784——From Sunderland Point to mouth of river are large quantities of sand, the
removal of which would create more expense than that of the obstructions in the river, 785——
A plan was contemplated in 1795 to divert the course of river through the peninsula of land
lying between Poulton Ring, in Morecambe Bay, and the Island Salt Area in the Lune, a
distance of 2½ miles in length, almost even with the level of high-water mark, which would
ensure a depth of 24 feet at low water, 786–789——Or we might retain the present river, and
connect Lancaster by means of a railway, with docks constructed at Poulton Ring, 790——
Docks at Glasson and the New Quay used by shipping unable to reach Lancaster or Preston,
793–797——Communicate with Lancaster by a branch of the Lancaster and Preston Canal,
798——Ships of 280 tons have reached Lancaster, 802——Of opinion that an additional 4
feet of water would not answer the purposes of the port or the expected increase of traffic, 808
——Original sum demanded as compensation of railway company 25,000*l.*, of which 10,000*l.*
was to be allotted for improving the navigation; is of opinion that all injury would be com-
pensated by such improvements, 815——The majority of the Commissioners are connected with
shipping or actual owners of vessels, 821——Is of opinion that the new Commission recently
appointed is desirous of carrying out any improvement suggested by the Admiralty or other

authority, and that if the railway bridge be raised to permit ships of 100 tons burthen to have access to the present quays, the 16,500*l.* would be entirely available for the improvement of the harbour, 822, 823——Is of opinion that the bridge can be so raised consistently with the level of the railway for the sum of 7,500*l.* in addition to the present cost, 824, 825——The 16,500*l.* exceeds Mr. Stevenson's estimate of expense for making the river navigable for vessels of 16 feet, 827——Commissioners could borrow 30,000*l.*, and doubtless the North-Western Railway Company, communicating with West Riding of Yorkshire, would be anxious for the improvements of the port, 829–30——Annual average income derived from tolls about 1,200*l.* a-year, 831.

Denham, Henry Mangles, Commander in the Royal Navy, and F.R.S. . . . . p. 40
Has been engaged 30 years in the surveying service, 864——Enumerates the coasts and ports he has surveyed either in command or as assistant, among others the river Lune and Morecambe Bay, in Lancashire, 865——Opinion as to the difficulty of maintaining a deep-water entrance to the Lune; discovered deep-water channel from Lune Deep to Poulton Ring, in Morecambe Bay, 868——Proposes to make docks at that place, distant only 2¼ miles from Lancaster; the ground is level, and easily connected by railroad, 872——Far preferable to any attempt at improving the navigation of the Lune, 874——River may be deepened to 16 feet from Glasson dock to the new bridge, 876——Expense of cutting canal (including breast-work and basins) from Poulton to Lancaster, 130,000*l.*, 878——This would give 12 feet of water at pier-heads without deepening; Harbour at Poulton would avoid the delays of navigating the river; has known ships of 17 feet detained six days bound to Glasson, 882——Compared his survey of 1844 with one projected in 1826, is of opinion that the latter could not have represented the features of the Banks, from the great dissimilarity of the two, 884——From common report, since 1826, the sands have not advanced, 885——Tide flows up the Kent within half mile of Leven's Bridge, 12 miles above Poulton; navigable only for flats up to Milnthorpe, 888——The enclosing of the bay would create a large tract of land, and facilitate railroad communication between Lancashire and Cumberland, 889——If such a project were carried out, a harbour at Poulton could not be maintained, unless by the Kent and Keer rivers being brought down on the south side of the bay, 890——Is of opinion that present depth at Poulton Ring depends on the flux and reflux of tidal water, 892——Depth of water at high-water springs, over the top of the sand called Cartmell Wharf, 9 feet, across on the western edge 13, three miles farther 9, then 13 feet below low-water level in the channel; 3 miles farther, 17 at high water, 893——Full 57,000 acres of tidal water would be excluded if project were carried out, 894——Every enclosure of sand would lessen the depth of the bay, 895——Is of opinion that any enclosure would be prejudicial to the outer channel; but inside would embank all bights and sinuosities, and straighten the river course, 896——From time immemorial, there has been deep water off Poulton Ring, ensuring a permanent harbour, 898——If 10,000*l.* were to be expended on the improvement of the Lune, would do so on lights and buoys, and perching the channels and shallows, 901——Is not of opinion that 7000*l.* is sufficient to deepen the river to 16 feet up to Lancaster, 902——Advises a floating light to be placed on the south-west spit of the Fisher Bank Patches, and tidal lights on Sunderland and Chapel Points, or Abbey Scare, by which means vessels could anchor in Sunderland Hole, or proceed over the 4 miles of flats or bars to Glasson by night, 906——Arrangements for lights are local, the Quay Commissioners possess the light of Walney, erected in 1789, paying general toll; it is imperfect in its action; and they have 3 or 4 buoys placed in an irregular way, under the superintendence of a buoy-master, 907–912——Considers that local trustees should have no control over the navigation beyond the high-water mouth of the river, 911——Walney light ought to be a channel light; it lights vessels from Liverpool to the Solway, and all vessels entering the bay pay toll, 914——It is a very important light; it consists of a tower 80 feet high, with 3 argand lamps and reflectors revolving, obscured every 5 minutes, showing bright but *one* minute, 918——Navigation of River Lune deteriorated within the last 20 years, 919——Is of opinion that dredging would have little effect, 921——System of harrowing better and cheaper, such as was used in Victoria Channel, Liverpool; but is of opinion it could not be used uccessfully in the Lune, 923——The extension of the sand is the cause of injury to the navigation, 928——Rise of tide at foot of Lune 28 feet; at Glasson Dock, at high spring tides, 24 feet, 21 at ordinary spring tides; at Lancaster Bridge, 11 feet, 931——Depth of water between the present bridge and intended viaduct, 15½ feet at high water ordinary springs, at low water 6½, 933——No possibility of any vessel proceeding above the first buoy at foot of Lune, 11 miles below Lancaster Quay, and 5 below Glasson Dock, without the aid of a pilot, owing to the want of a light, and a proper system of buoyage, 933——Is of opinion that if the whole of such estuaries were placed under proper independent authority on the part of Government, that the navigation might long ago have been benefited, 936——Has observed the same neglect in navigation under other local authorities, particularly seaward of the mouth of the river, and considers that some competent authority, not local bodies, should direct the placing of buoys and other necessary improvements. 938——Harbours would then eventually be much improved, and the dues on shipping not misapplied, 939——Persons at present employed are not supported by the local authorities, and the latter do not possess sufficient knowledge on the subject, 942——Undertook to scour the Victoria Channel, Liverpool, but immediately after resigned a lucrative appointment, owing to the vexatious difficulties that arose, 944——Considers that in the Lune, where the tide rises 18 feet, dykes or walls would be necessary to direct the current, 945——The upper surface of dykes should come 3 feet above high water level, 946, 947——In case the dykes on the Clyde were pulled down to make way for half-tide dykes, it would confine the stream to steam navigation, as it would not be safe for sailing vessels, 948——Is of opinion that banks in the estuary of the Clyde, require all the tidal water, but that within the river dykes should be raised above high-water level, 949——The last half of the tide-scour is necessary to keep the channel deep, also as great a flow of the tide upwards as can be got for the sake of the outer banks, 951——Considers that the descending tidal water would not have the effect of keeping the channel clear within the river, 952——For improving the port of Lancaster, recommends abandoning the Lune to its present course *in toto*, and by establishing a harbour at Poulton, to enable a ship to approach within 3 miles of Lancaster at low water, 955——Should an embankment be ran across Morecambe Bay, would recommend that the sea reach of the Lune over Sunderland and Cockram Sands be assisted by more buoys, and the interior of the

estuary straightened to define the outfall of the river, 956——Various plans for embanking Morecambe Bay have been suggested, 957——Considers the line from Poulton to Point Comfort feasible and advantageous, in stopping present dangerous indraught into the Bay, 959——Does not consider such an embankment would be mischievous, 960——Depth of water at embankment would vary between 41 and 9 feet, 961——States his opinion as to the phenomenon of the Lune Deep, where the depth jumps from 3 to 154 feet; thinks that the mouth of Morecambe Bay, now 8 miles across, was originally only 1½ miles. Lune Deep was then the outlet of all the rivers, but that it is now filling up, as the bay widens, as may be judged by the submarine spits which all point at it, 963–4——An embankment of pile-framing and rubble-stone might be built from Poulton, across the bay, sufficient to resist the action of the sea, and to carry a railway, 966——Is of opinion that the embankment would not destroy the entrances of the harbours of Lune, Wyre, and Piel, 967.

Surveyed the estuary of the Duddon water, on the coast of Lancashire, 1451——A solid embankment across it, would stop vessels that now go to Broughton quarries; but is of opinion that it would be more beneficial than otherwise, as the estuary presents no refuge capacity, 1453——At the proposed line, 3 miles below the Burlington slate quarry, there is 20 feet depth in the channel at high-water ordinary spring tides; vessels drawing 6 feet reach 4½ miles higher; open punts go up to Duddon Bridge, and the tide flows ¼ of a mile above, 1458——Rate of tide at proposed place of embankment, 3 knots on the flood and 3½ on the ebb, which would be stopped by the embankment, 1460——Considers that it would cause slight privation of water-carriage to the surrounding country; a railroad is in progress of formation from Kirby Pool to Piel Harbour, 1463——This estuary is the outlet for the waters of the Duddon and Kirby Pool, but is not aware of any traffic upon them, 1465——Duddon estuary drains the lakes, Kirby Pool, Simpson's Beck, and Salthouse Pool, 1469——And the embankment would entirely destroy its navigation, 1472——Would exclude about 1300 millions cubic feet of water on every tide, 1473——In order to dispose of the waters above the proposed embankment, either sluice gates or a new channel must be made, 1474——The seaward side would no longer be navigable, 1476——Considers that the railway might be carried out by a circuit of eight miles, and so avoid the embankment, and all interference with navigation, 1479–81——Recommends the crossing to be by an embankment with arches, 1483——Depth of sand is nine feet, then clay; piles and rubble-stone wall form the embankment, 1490——Contemplates shutting out entirely the flow of the tide, both here and in Morecambe Bay, 1495——Considers that owing to the long flat of two miles, extending off shore, it is impossible, either by dredging, buoys, or beacons, to maintain a channel so as to make the Duddon even a limited refuge harbour, 1503——Embankment at Salthouse Pool was made in 1830, to redeem 260 acres of marsh, over which the sea ranged two feet at high water springs, thereby excluding 7½ millions of cubic feet of water, 1506——There are several other embankments, 1508——A railway might be carried along shore to the southward of Millom Hill, 1509——Numerous objections to constructing a railway from Poulton to Cowper Point, to Chapel Island, and thence to the mainland on the north-eastern side of Morecambe Bay, 1510——It would shut up ten rivers or streams, 1511——With the exception of the proposed pier at Poulton Ring, considers an embankment across Morecambe Bay of public advantage, 1512——Is of opinion that the shutting out of so large a body of water would silt up the different channels in the bay; yet would not be injurious to the early tide ports, the Lune, Wyre, and Piel, but destroy all above, with the proposed port at Poulton Ring, 1515——Observed several encroachments on the banks of the Duddon and Morecambe Bay, 1518——All ebbing waters do not scour a bar, some deposit on it, and increase it, 1523——All water assists in keeping open a channel, but as that is kept open the bar works out seaward, rendering the entrance like that of Liverpool, 1525——Where a bar has extended to the limit of the velocity of the ebb tide, it will go on accumulating, and is hopeless; if it lie within the range of a rapid ebb stream, artificial means may be useful, 1526——Extent of bar depends not so much on depth of water as on reaching the fair channel stream, the Wyre for instance; the Duddon sands will project till they reach the fair set of tide in the Irish Channel, 1527——An estuary that presents the form of a prostrate cone, with its base outwards, is hopeless, 1528——All estuaries do not present the same features; distinction drawn between the Dee and the Mersey, 1529——If the Burbo and East Hoyle Bank between the Mersey and Dee did not exist, the channels of the river would not be kept open, 1532——To improve the Lune sea reach it would be necessary to embank Sunderland Point both in its river and sea face, 1534——An embankment across Morecambe Bay would have a beneficial effect on the sands at mouth of Lune, by diminishing the scour of the bay, and consequent deposit of sand, 1538——If Cartmell Wharf were walled up, the same effect would be produced on the channels of the Kent and Leven as on the Lune, 1541——Lune Deep was the original outfall of all the waters of the Lune and Morecambe Bay, 1543——Conjectures why it has not been filled up by the sands, 1544——In case Morecambe Bay be cut off by an embankment, the sands would immediately break in, and the Lune Deep very slowly fill up, 1545.

MACDONALD, JOHN, Secretary to the Trustees of the Arbroath since 1839 . . . . p. 45

Since the Act of 1839, the sum of 58,000*l.* has been expended in purchasing and improving the harbour, 975——Act gave power to borrow 50,000*l.*, and the trust is now 3000*l.* in debt, 976——Depth at high water 12 feet; at low water the harbour is dry, 978——Proposes to deepen from 3 to 6 feet, extending 233 yards from pier-heads, 980——Boulders and soft freestone rock to remove, at an estimate of 9000*l.*, so as to admit a vessel drawing 16 feet at high water, 988——No funds to do it; interest of debt 2350*l.* a-year; 800*l.* a-year expenses of management; revenue 3050*l.*, 993——Unless the entrance be deepened, revenue will fall off, 995——If deepened, all coasting vessels would be able to take the harbour, 1001——Of the money borrowed, 25,000*l.* are on the personal guarantee of individuals connected with the port, 1004——Area of the harbour 6 acres, works stable, and foundation deep, 1010——Estimate is only for deepening, 25,000*l.* additional would be required to finish the inner docks, and north pier, 1012——*Capt. Washington*, R.N.—If deepened as proposed, it would be a tidal harbour of refuge for 12 hours out of the 24, for all vessels not exceeding 10 feet draft of water, 1021——Very great need of a harbour on this part of the coast of Scotland; in the year 1800, not less than 13 vessels were wrecked in one night, within 6 miles of Arbroath, 1027——Depth of water at one cable's length from low-water mark is 18 feet, and 6 fathoms at a quarter of a mile beyond, 1029——Knuckle Rock and Cheek Bush should have beacons on them, 1030——Does not wish a passing toll granted for its support, 1032——Is of opinion that Arbroath, from the public spirit of the Trustees in spending 58,000*l.* on its internal improvements, has greater claim to a small grant from Government than any other port he is acquainted with, 1033——Mr. *Macdonald.*—Deepening the port would increase the traffic, and thus the dues would pay off the debt, 1036——Unless it is done, the works will deteriorate, 1039——Government gave no aid towards making it, 1040——All the services of the trustees are gratuitous; they are 19 in number, and publicly elected: the accounts are audited and published annually, 1053—— Population of Arbroath, 15,000; chief trade flax-spinning and manufactures, 1058——In 1840, 777 vessels of 48,193 tons, entered the harbour, 1069——Harbour dues vary from 1¼*d.* to 1*s.* 6*d.* per ton. If the money sought were advanced, it would be scrupulously applied to improvements of the entrance, 1082.

Stead, Patrick, a Merchant and Maltster at Halesworth, on the River Blyth, in Suffolk . p. 50
Has traded to Southwold since 1817; exports annually about 20,000 quarters of malt and corn, and imports 3000 tons of coals, 1088——Considers that the merchant pays the port dues, 1089 ——Has made serious complaints for many years against the state of the harbour of Southwold; the bar is very bad, 1091——Has reason to believe the harbour was formerly in a better state, 1094 ——*Lieut. Ellis.*—Admits that such is the effect of the evidence referred to, but does not concur in it. A lighter was built formerly, to lighten vessels outside the bar, but was sold in 1815 for a dredger, 1100——Larger vessels probably entered the port formerly before the river was curtailed by encroachments of the sea, 1101——Mr. *Stead.*—Has made repeated representations since 1827, as to the neglected state of the port, 1114——Recommends dredging and cutting through the Bellar Shoal; estimates loss on corn shipped at Southwold at 1452*l.* a-year. Got no redress, 1114–15——In 1830 a new Bill was obtained; tried in vain to get the interests of the town represented in it; 32 Commissioners appointed; landowners, clergymen, to be self-elected, and 2 bailiffs of Southwold, 1126——A public meeting at Southwold, in order to get a clause of a more open character, but in vain, 1127——Harbour since that time has been at times very bad ; in 1838 or 1839 the bar was for several days dry at high-water, and no vessel could get in or out, 1143——Attributes it in great part to the embankment of the marshes by the adjoining landed proprietors, 1145——From Mr. Walker's Report 1504 acres of marsh land have been embanked, thereby excluding 148 million cubic feet of water on every spring tide; there were also 1200 acres, at a similar level, embanked, which he did not survey, 1148——Knows of no authority for such embanking, 1150——The chief part of the embankments took place prior to 1806, 1157——Cites Rennie's opinion for the injury to the harbour caused by them, 1168——Case of Wells submitted to serjeant Grose, who pronounces all such embankments nuisances, 1177——Decided in 1781 against embankments, 1178——Cites Chitty's opinion on Southwold, who declares the embankments to be nuisances, 1183—— Applied to the Admiralty, Woods and Forests, and House of Commons, 1184——Wolsey Creek is the lower limit of the Blyth Commission, 1193——Governing Act of Blyth Commissioners, 30 Geo. II. cap. 47, 1198——Next to the removal of the embankments, the river should be dredged and Blyhro' Bridge, which Mr. Walker terms "a disgrace to the county," should be removed, 1200——Wangford Bridge, of far inferior importance, has been rebuilt, 1201——There is a large extent of embanked land to the westward of Wolsey Bridge, not mapped by Mr. Walker, in addition to the 2704 acres of enclosed land which he states in his Report. Estimating the value of the land at 30*s.* an acre, the back rent due would be upwards of 300,000*l.* Witness has asked the Southwold Commissioners to use a rake to deepen the river; to employ a small steam tug to tow vessels in and out of the harbour; and to build piers of concrete, faced with rubble stone, instead of wooden piers, which the worm destroys. Comparing the Report of Edwards in 1757 with that of Walker in 1840, the flow of the tide at Blybro' Bridge was the same then as it is now; it cannot therefore be said that the embankments have increased the flow of the tide. Is of opinian that the expenses of management are very high, and that the dredging cost twice as much as it need have done, 1203——In the Tay, near Perth, the dredging cost 2¼*d.* per ton for gravel and 3½*d.* per ton for clay. The detention of vessels for want of water over the bar has been excessive; in consequence has been compelled to give up the shipment of corn, as also has another large corn merchant, 1210 ——Is distinctly of opinion that the lands now enclosed and formerly overflowed by the tide are Crown lands, 1213——Chairman of Southwold Trust produced Mr. Rendel's abstract opinions at the annual meeting, as an argument that the embankments had done good instead of harm; and Mr. Rendel now states that his opinion is by no means applicable to Southwold Harbour. A promise was made to the witness that four Commissioners might be elected from the shipowners, &c. of Halesworth, but this was not done, 1216——When the Harbour Bill was in Committee three of the members of the Committee elected themselves into the Commission. Several petions against it. Considers himself very hardly dealt with, as he pays one-third of all the port dues. The qualification of a Commissioner is too high; is of opinion that all their proceedings are illegal, 1218——Has complained of the embankments to both houses of Parliament, to every department of Government, and taken every constitutional means to obtain redress, but in vain, 1224——Has repeatedly applied, but has never been able to see the proper account books, such as the Act requires, 1225——Gives in account for 1843, and remarks on a charge of 500*l.* for labour, 1240——Refused sight of surveyor's and minute book, 1241——Dredging at Perth costs 2¼*d.* and at Southwold nearly 1*s.* Owing to the bad state of the harbour the freight on corn and malt is about 1*s.* 6*d.* a ton more than from Yarmouth. At Southwold harbour dues on coal 1*s.* 2*d.* a ton, at Yarmouth only 6*d.*, 1257——The marsh embanked to the westward of Wolsey Bridge is about 300 acres in extent, and below the level of high water springs, 1263——Out of all the embanked lands and encroachments on the river, the only thing he has ever known ordered to be removed was an encroachment made by witness in marking the boundary of his malt-houses, which order was signed by the Chairman, 1265–6——Was present at the inquiry into Southwold Harbour made in 1844 by order of the Admiralty, and is satisfied that it was quite public, and that every one was invited to bring forward any evidence which could throw light upon the subject, 1267.

Blanden, William, Wherryman, of Halesworth, in Suffolk . . . . p. 61

Is 76 years old, and has traded 64 years on the river Blyth, 1277——Is of opinion that the embankments have caused damage to the harbour 1278——Remembers the embanking of Bulchamp and Blythbro' Saltings, 500 acres in extent, formerly covered by water, and which be has often crossed in his boat, 1278–83——Current now much less rapid than formerly, 1284——Remembers vessels drawing 9½ feet coming in at half flood, and now barely at high-water, 1288——Blythbro' Bridge is a great impediment to navigation, boats cannot get under it at high-water, 1300——There is not the flow of water in the river now that there used to be, 1301——The lower part of the harbour has been improved by dredging, &c., since 1830; there was less detention in passing up and down the river formerly than now, 1311.

Ellis Francis Wilson, Lieut. R.N., Harbour Surveyor of Southwold since 1829 . . . . p. 62

Shows by extracts from history the former bad state of the harbour from 1328 down to 1747; then quotes the Minute Book, which speaks of the harbour being cleansed out, but says nothing of its being blocked up, 1313——From Maggs' Hand-book it appears that between 1805 and 1818 it was dug out 13 times, 1314——Minute Book contains no entry respecting the embankments being made, nor any complaints against them prior to 1830; great improvements in the lower part of the harbour since that period; from 1830 to 1839 harbour was not once blocked up, 1325——Knows nothing of any embankments having been made except from the Reports of Rennie and Walker, 1330——Is of opinion that the embankments have not been an impediment to the flow of the tide, 1332——Is of opinion that if the embankments were removed a larger body of water would not come into the harbour, 1334——States that in 1840 Mr. Walker, in his Report, makes the rise of tide at Blythbro' Bridge 6½ feet, and as Edwards in 1757, and Rennie in 1830, make it only 5 feet, consequently 1½ feet of rise have been gained, 1334——River has lately been dredged, which has admitted more water, 1337——Is unquestionably of opinion that by admitting in every possible way the influx of the tide the river would be improved, 1344——In E.N.E. gales the harbour blocks up by shingle, 1346——Considers that the accounts of the harbour are kept in a regular manner; lays on the table printed abstract of accounts from 1836 to the present time, 1350——Mr. Stead has never applied to him for an inspection of the surveyor's or collector's book, 1352——Declined to show him the Minute Book, which he had no claim to see, 1353——The harbour work is publicly contracted for, 1355——From 1833 to 1836 the dredging was done by their own steam dredges, but the wherries and labour were contracted for at 4¼*d.* per ton; in 1839 the Lowestoft dredge was hired, and the contract for wherries and labour was 5¼*d.* per ton; the contract alluded to in the Tay, by Mr. Stead, at 2¼*d.* per ton, was for labour only. The town of Halesworth is more fully represented in the Harbour Commission than Southwold, 1361——Is of opinion that the Southwold Commissioners have no power over the embankments on the Blyth; Blythbro' Bridge, also, is out of their jurisdiction. Salary of Harbour Master and Collector only 100*l.*, at Yarmouth it is 500*l.* a-year, 1361——Admits the accuracy of Mr. Walker's Report of 1841 as to facts, but thinks his calculation fallacious, and does not believe that 150 million cubic feet of water at every spring tide have been excluded from the harbour, 1364——Is of opinion that the embanked lands, had they remained open, would have silted up ere now, 1365——Admits that Rennie says, in his Report of 1830, that spring tides rise at Southwold 6½ feet, and at Blythbro' Bridge nearly as much, but asserts that he says before that the rise is only 5 feet, and Edwards, in 1757, says the same, 1368——The volume of fresh water brought down by the river Blyth, except in wet seasons, is insignificant, 1370——In order to improve Southwold Harbour it would be desirable to widen and deepen the channel of the rivers, and to clear out the creeks, by which a great additional quantity of water would be brought in and out of the harbour, giving a greater momentum to the current, and thereby very much improve the bar. If the above means were adopted would expect great increase of water over the bar, which is now only 10 feet at high-water, 1380——Spring tides run out at 4 knots an hour, 1381——Approves generally of Mr. Calver's plan for improvement of the entrance of the harbour; it is the best hitherto proposed, 1383——Is of opinion that extension of the piers would be prejudicial; the *teredo navalis*, or some similar destructive worm, abounds at Southwold, and does much damage to piles, &c., 1384——The Harbour and River Commissioners should be merged into one; would suggest the formation of a Central Harbour Board, with local inspectors, to have control over all harbours in the United Kingdom; to have one general Harbour Act, assimilating the constitution of the local Boards, provisions, penalties, dues, &c., to regulate pilotage; and to have annual returns of receipt and expenditure, and all other things relating to each harbour, 1379.

Stephenson, George, Engineer to the Whitehaven and Furness Junction Railroad . . . p. 68

Proposed line goes along the coast from Whitehaven to St. Bees, Ravenglass, and across the Duddon Sands to Furness; the object is to carry the iron-stone, 1386——No part of the plan, at present, is to cross Morecambe Bay, but it may be next year, 1387——Proposes to cross Duddon Sands by an arched embankment 1½ mile long, 1395——Would probably cut off 5000 acres of the Duddon Sands, at 4 miles below Broughton, 1396——Means to make an outlet for the river Duddon, but this is not in the Bill; mode of proceeding would be by piles; then to lay a wooden railway at top 6 feet above high-water mark, and drag waggons to and fro loaded with stones to be dropped between the piles, and thus gradually raise all parts above high-water, 1400–1——The bed of the river above the embankment will become land, claimed by the Crown and the neighbouring proprietors, 1405——If this line were obtained it would be a reason for asking for a line, next year, to cross Morecambe Bay, 1411——Complaints against the embankment have come from Broughton, and it is intended to give that place a railroad instead of the present navigation, 1412——Would not propose a swing bridge; the current of water would be so strong, that no engineer would undertake it, 1413——To cross from Shaw Point to Angerton would carry the line a long way round. The present proposal is the only line witness would undertake, 1416.

Lord Advocate of Scotland . . . . p. 70

Explains the state of the suit pending between the Montrose Harbour Trustees and Sir James Carnegie relative to the embanking of certain lands upon the banks of the South Esk near Old Montrose.

Lonsdale, The **Earl of**, Chairman of the Whitehaven and Furness Railway . . . . . . p. 77
Is proprietor of about 1000 acres of land on the side of the Duddon Estuary, 1546——The 250 acres of land embanked was under the Millom Enclosure Act of 1820, and which empowers to enclose about 1000 acres, out to mid-stream, 1551——Thinks that the opinion of the Admiralty was not asked as to whether such an inclosure would interfere with the navigation, 1554——The land was chiefly dry at low-water, but always covered at flood, 1556.

Leslie, James, C. E., of Dundee, Engineer to Montrose Harbour . . . . p. 78
Was consulted by Sir J. Carnegie, in 1841, about the best mode of protecting his land from being encroached upon by the river South Esk, and recommended that he should divert the channel of the river a little, which he did; witness recommended to Sir J. Carnegie not to attempt to enclose land, but in the following year he ran an embankment across and shut out the water, 1566——The first operation would not have made any alteration in the flow of the tide, 1569——By the latter 66 acres, over which the water flowed 4 feet at spring tides, has been enclosed, and 12 million cubic feet of water excluded on every spring tide, 1581——A prior embankment of 50 acres, made in 1831, has excluded 9 million of cubic feet of water on every tide, 1587——Is decidedly of opinion that shutting out the tidal water is injurious, 1589——Is acquainted with the encroachments on the Tay near Powgavie, about 6 miles above Dundee, where a dyke upwards of 1000 yards long has been run out from the north shore into the river; the effect of this and other walls would be to silt up an area of 2000 acres in extent, or about one-ninth of the whole area of the Tay between Dundee and the mouth of the Earn, 1600——Proposed two years since to cut away a projecting point of rock at Magdalen Yard in order to set the current past the sea face of the docks at Dundee, 1606——Tried formerly to dredge away the Ballast Bank, 1613——As a general principle would recommend an estuary to be preserved entire, 1624——Is of opinion that the point of the Middle Bank has not come lower down since 1832. It would be a great advantage to Dundee Harbour to have the Fowler, Beacon, and other rocks removed, 1638——Is not aware of any great fresh in the Tay within the last 10 years; does not attribute the deepening at Tay Bar to any improvements in the upper part of the river, 1640——Recapitulates the chief harbours that he has examined and reported upon, 1648 *a*——The chief obstructions to the propagation of the tide in rivers are straits, sinuosities, fords, and shoals, 1648 *c*——These may be removed by blasting, dredging, straightening the channel, &c., according to circumstances. The depth of a river in its lower part is almost entirely due to the tidal waters, in its upper part to freshes, 1648 *f*——At Dundee the cost of dredging mud and sand, and depositing it above high-water mark is from 7*d.* to 7½*d.* per cubic yard, when dropped from hopper punts about 6*d.*, 1648 *i*——Is of opinion that a Harbour Board in connexion with the Admiralty to look after encroachments and the general interests of harbours, and to decide whether any projected work was desirable or not would be highly beneficial, 1648 *j*.

Burnes, Adam, Solicitor, and Clerk to the Montrose Harbour Trust . . . . p. 82
States the present position of the suit pending between the Montrose Trustees and Sir J. Carnegie, respecting encroachments on the banks of the South Esk, near Old Montrose, 1652——In June, 1842, remonstrated by letter, and in person intimated an interdict against them, 1656——Also memorialized the Admiralty, and Mr. Rendel, C.E., was ordered to inspect and report upon the works, 1657——Having recently completed a wet dock and other works at Montrose, at a cost of 42,000*l.*, the trustees have expended all their funds, which alone has prevented their instituting legal proceedings; they, therefore, applied to the Admiralty to help them, 1663——The trustees have been always anxious to guard against any encroachment upon the tidal waters of the basin, 1668——Three other encroachments have been made by the predecessors of Sir J. Carnegie, one in 1817, another in 1830, and a third in 1831, of about 60 acres each, 1681——The revenue of the harbour is 3,400*l.* It would be a great improvement to remove a rock called the Stone, at the entrance; or at least to put a beacon on it. Is of opinion that this is the duty of the Commissioners of Northern Lights, 1677.

Stevenson, David, of Edinburgh, Civil Engineer . . . . p. 84
Has surveyed and reported upon the Dee, Ribble, Lune, Wyre, Tay, Forth, &c.; one general principle in the improvement of rivers is, that as the fresh water cannot be materially increased by any work of art, every effort should be made to increase the duration of the tidal influence, by removing obstructions, as fords, jetties, weirs, and the slope of the river's bed, 1685–6——In all our rivers at low water the slope of the surface is from the sea *upwards*, but at other times it is from the sea *downwards*, and it is very desirable to reduce this nearer to an equality; in the Dee at low water there is a fall of 11 feet from Chester to Flint, a distance of 12 miles, but on one occasion it was found that there was a fall of 8 feet nearly from Flint *upwards*; also, on the Lune, between Lancaster and Glasson, 6 miles distance, there is a slope in the bed of 11 feet, and on one occasion the surface of the water had a slope from the sea of 4 feet 4 inches *upwards*, 1687——Impediments may be removed by excavation, by guiding the course of the stream, or by dredging. From 5*d.* to 6*d.* per cubic yard is a fair price for dredging gravel, including all expenses, 1690——Depths of rivers chiefly due to tidal waters. Detritus brought down by the rivers more to be feared than deposit from the sea, 1692——Tay and Ribble are instances of the beneficial effects of works designed in conformity with the above principles.

In the Tay, boulder stones of 50 tons weight have been removed, a depth of 3½ feet has been gained over the fords. Embankments are sometimes useful, but in general it is desirable to give compensation for them by deepening the channel, 1697——The improvement in the tidal phenomena has been in proportion; has gained 50 minutes in time, and 1¼ mile per hour in speed, on the first wave of the flood tide, 1700——A million cubic yards of water, in addition, passes Newburgh on every tide, 1705——Conceives the Tay capable of further improvement, even to 18 or 20 feet depth at high water spring tides at Perth, at a cost of 50,000*l.* The average slope of the bed of the river is still 5 inches a mile from Perth to Balmbreich, and 10 inches a mile from Newburgh downwards, 1713——Jetties also should be removed, which may be done by a late decision of the Court of Sessions, 1715——Depth of water from Flisk downwards is at no place less than 30 feet at high water springs, 1724——Has found great difficulty in persuading the landowners to remove jetties, &c., 1726——Is of opinion that the Middle bank is of sand, 1736——Is acquainted with the embankment begun on the north shore of the

Tay, to extend from Cairnie Pier downwards. The proprietor of the adjoining land was permitted by the Perth Harbour Trustees to deposit materials on a line approved of by the engineers to the river, for the purpose of directing the current favourably, and for improving certain fishing stations; but witness is not prepared to say what may be the effect of completing that embankment, as proposed in the proprietor's application to this Commission, 1770.

On the Ribble spring tides formerly rose only 6 feet at Preston, and flats carried the cargoes of vessels up from Lytham, 1740——About 30,000 cubic yards of rock have been excavated near Preston; 800,000 tons of gravel have been dredged, and 7½ miles of low rubble wall have been erected in the lower part of the river. Range of tide at Preston has been increased 4 feet; in the beginning of 1840 no vessels but flats came up, and now 95 vessels in a quarter of a year have come up to the quays, and the dues have been nearly quadrupled, 1741——Ribble is susceptible of further improvement; from 18 to 20 feet might be obtained at Preston. Tide flows 4½ miles above the town, or 21½ miles from the Irish Sea, 1746——Cost of the late works 47,000*l.* nearly, 1749——Similar improvements might be made in the Lune, Forth, Trent, and Dee, 1755——The Dee is an instance of injury from artificial obstructions placed in order to gain land, about 4,000 acres have been enclosed by an embankment 7 miles in length, the line of which has been most injudiciously laid out as regards navigation. A weir has been erected at Chester, rising 11½ feet above the bed of the river, which dams the water up for 6 or 7 miles, and checks the flow of the tide above the town. On the Lune, also, land has been enclosed, and weirs also exist which check the flow of the tide. On the Wyre there are obstructions. On the Ribble the jetties formerly were very prejudicial, 1759——Has surveyed the Forth from Stirling to Alloa, 1771——There are seven fords, consisting chiefly of whin boulders; these should be removed, so as to gain 3 feet water up to Stirling; the depth is now 10 feet, it should be at least 13 feet at high water spring tides, and then vessels might reach Stirling in one tide. The cost of such works would be 9,400*l.* nearly, 1773——Alloa and Tillibody Islands are surrounded by embankments, and there are several others which exclude the tidal water, 1778——Tide flows to the Cruive of Craig Forth, 4½ miles above Stirling, where it is impeded by a mill dam, against which it rises 4 feet, 1787——The distance by the river from Stirling to Alloa is 10½ miles, by land, 7½, 1795——The slope of the bed of the river between these two places is 11½ feet. Ordinary spring tides rise at Leith, 16½ feet; at Alloa, 19 feet; at Stirling, 8 feet, 1799——Is aware of embankments near Kincardine, but not of their extent, 1804.

Is of opinion that it would be beneficial to establish a central Harbour Board, in connexion with the Admiralty, to have the superintendence of all the ports and navigable rivers of the United Kingdom. Considers the rivers as so many public highways, which should be guarded for the public against the interests of the landowners, which are in most instances hostile to the interests of navigation, 1760——Is of opinion that every local Harbour Board should have a portion of its Commissioners appointed by the Admiralty, so as to be uninfluenced by property or local bias, 1763——There is no doubt that such a Board established a century ago would have prevented many injuries that have been produced by encroachments, 1764.

Galbraith, William, Town Clerk of Stirling . . . . p. 90

A memorial has been presented by the Commissioners of the Forth Navigation, complaining that the navigation of the river between Alloa and Stirling is much obstructed by fords and shallows, 1806——An application has been made to the Treasury, asking to advance money on the security of the rates, 1807——Revenue of port, 350*l.* levied by dues on tonnage, 1813——Act of 1843 authorizes to raise 10,000*l.*, but only half of its till 5,000*l.* has been expended on the improvement of the river, 1824——Have only raised 1,600*l.*, the greater part expended in obtaining the Act, 1825——Vessels of 150 tons have reached Stirling at high water spring tides; wool, grain, and limestone form the chief trade, 1829——The only guarantee that can be offered as payment of the interest of any loan are the rates authorized by the Act to be levied; those at present amount to 350*l.* a-year, on 5,000*l.* being expended these might in part be doubled, and thus produce 600*l.* a-year; on 4,000*l.* more being expended, the full rates might be levied, or 850*l.* a-year; and thus, although there were no addition to the present traffic, ample funds would be available to pay 3 per cent. interest on 10,000*l.*, and to form a sinking fund of 400*l.* a-year for the redemption of the debt, *App.* p. 163. Would gladly concur in any arrangement on the part of the Admiralty for improving the river, 1843—The shipping belonging to Alloa amount to 99 vessels, of 17,392 tons; to Stirling, 24 vessels, of 1,048 tons; and 3 steamers. Arrivals and sailings at Alloa, 806; at Stirling, 526 yearly, besides 492 steam trips, 1848——Has tried in vain to borrow money from any public body or Scottish bank, 1849——Craig Forth Weir was by a grant of one of the Kings of Scotland to the then Lord Elphinstone, for his salmon fishing. The town of Stirling objected to it, but it was overcome. Has furnished a copy of the grant to the Commission, 1860.

Rendel, James Meadows, Vice President Inst. of Civil Engineers . . . . p. 92

Certain abstract questions relative to rivers were put to him some time ago by Lord Stradbroke, 1866——The questions arose from evidence given by witness shortly before, respecting the river Mersey, in which it was shown that the water did not rise to the height in the higher part of the estuary, that it did at Runcorn, owing to its escaping into the creeks near the mouth of the estuary, and thus the momentum of the tidal stream was impaired, and any work that had the effect of correcting that loss of momemtum would have the effect of carrying a larger body of water into its upper portions, 1867——The answers to the questions were certainly not given in reference to Southwold Harbour, 1872——Was not aware that the answers had been considered applicable to Southwold for reasons stated, 1873——Has not been able to lay down any general principle for the improvement of rivers, but must treat each case according to its peculiarities, 1875——In the case of Southwold the bar is the first point to be treated, and its state depends on the quantity of water passing to and fro over it; anything therefore that diminishes the quantity of water in the estuary would unquestionably have a tendency to increase the bar. There are many harbours, Berwick for instance, where the stream is so great at the piers, that it amounts to a greater objection than the bar itself, and consequently there it is very desirable to lessen the stream, 1878——Inequalities in the bed and shores of a river are the chief obstructions to the propagation of the tide. Tide is often higher at entrance than in the upper parts, owing to the contracted mouth it has not time to fill the basin within.

Great advantage of having a harbour in such a form as to have a higher tidal flow at its inner end than at its entrance. In the Mersey, the tide rises at Runcorn, 20 miles from its mouth, 18 inches higher than at Liverpool, but from Runcorn to head of estuary it falls. To remove the stricture at Runcorn would be an advantage. Has a great objection to a stronger stream than is necessary to remove the bar, for it creates so much disturbance, that it is the cause of evils as great as the bar itself, 1881——Is of opinion that the Slob or mud bank on either side of Belfast Lough might be advantageously embanked, for there is both ample fresh and tidal water, and no bar. In Lynn the harbour is always best in winter, owing to the extra scour caused by the increase of shipping, 1882——In all estuaries encumbered by sands at their entrance nothing that tended to lessen the quantity of water going into the harbour ought to be permitted; but embanking does necessarily imply a diminished quantity of water in a harbour, 1883——If the tide at upper end of a river does not rise as much as at entrance, it will be of advantage to cut off any creeks in its lower part, 1885——The whole engineering condition of a harbour should be minutely investigated before any engineering works ought to be permitted, 1890——It is the nice discrimination of all minute differences which constitutes the value of an opinion in cases of this kind, 1895——Harbours are frequently injured by the mouth being too narrow more than being too wide, 1896——Harbours require constantly watching, 1898——More harbours have been injured by injudicious improvements than by natural decay, 1899——Considers that local interests often interfere most destructively with the general interests of navigation, 1930——Is of opinion that every harbour should be placed under the superindence of Government control, provided that Government could command properly qualified persons, otherwise a greater evil would arise from ignorance than from local cupidity, 1901——Considers the Admiralty the proper Board to have conservancy of the harbours of the kingdom; no minor Board would possess sufficient influence; the present practice of referring particular cases to men of eminence in their profession is probably the safest course the Government can adopt, 1902——Is of opinion that it is most material to the preservation of the public harbours of the nation that there should be at once made accurate plans, comprising the full extent to which the tide flows. It is only recently that the Admiraty surveys have been worth anything, as far as the improvement of the harbours is concerned, 1907——Every change in a harbour should be recorded upon an accurate plan; nothing would help an engineer more than thus to know the history of a harbour he is called upon to improve, 1908——Is of opinion that no visiting engineer, no one but a resident engineer or harbour master could record such changes and minutiæ as ought to be noted in order to render the record useful, 1909——Would prefer the reports of local engineers to those modified by the views or opinions of a superintending engineer, 1910——The control of harbours should rest with the Admiralty, and considers their decisions have been judicious, and maintained with proper firmness. It ought to be an indictable offence to interfere with a harbour or the flow of the tide without the sanction of the Admiralty, 1914——Knows many cases where great injury has been inflicted by works authorized by Parliament, 1916——Knows many instances of damage from neglect; also encroachments made silently and likely to escape most observers. Has known instances where encroachments have begun with wickerwork, then stone dykes, then shut the tide out altogether, 1918——A public Harbour Act is wanting. The Admiralty should have a veto on the appointment of harbour trustees. Has often reported to the effect that a certain number in all harbour trusts should be appointed by Government, 1921.

Was employed by the Admiralty to report on an embankment made by Sir James Carnegie in the basin of Montrose. Recommended compensation to be made by deepening the channel. Observed many other embankments on the shores of the basin. Montrose is a case in point in which a good engineering and nautical plan of the port is absolutely necessary. Ten and a half millions of cubic feet of water have been excluded by the recent embankment at every spring tide, 1926–35.

CHAPMAN, HENRY CLEAVER, Merchant and Shipowner at Liverpool . . . . p. 98

Has been 12 years at sea, trading to London, and 15 years resident at Liverpool, 1939——Was at Liverpool when Captain Denham called attention to the Victoria Channel, 1944——This channel is delineated in Greenvile Collins' "Coasting Pilot," of 1688, but had fallen into disuse for want of buoys, 1946——After much importunity Captain Denham got permission to buoy it, and afterwards it was lighted; it is now the best channel into Liverpool, and witness would as soon take a line-of-battle ship in by night as by day, 1951——Has never sailed a ship through the Victoria Channel, but has frequently been in and out in steam-boats and yachts, 1992——The works of the docks have silted up the Rock Channel. The appointment of a Conservator has given great satisfaction to the commercial interests of Liverpool, 1961——Between 1830 and 1839 the state of navigation as regarding lights, buoys, and management was very bad, 1968——Attributes the change to Captain Denham's exertions, 1970——Considers that it would be highly advantageous to have a general superintendence over all the harbours, 1971——So badly is it considered that the docks are managed at Liverpool that some merchants were on the point of memorializing to have them put under a Government commission, 1976——The lights, buoys, &c., are all under the Dock Committee, 1982——It is not of necessity that any of the Dock Trustees should be seamen, 1986——They consist of 13 deputed by the Common Council, and 8 elected by the dock rate-payers; the former depend upon the political opinions of the majority, 1988——When the trustees apply for a new Bill Government should embrace the opportunity of altering the constitution of the dock trust; the rate-payers should be convened annually, the trustees should give an account of their trust, and the shipowners and merchants should be allowed an opportunity of stating their complaints, 1993.

HICKS, CHARLES, DAVIN MANSER, and HENRY STOCKS, Chairman, Clerk, and Harbour Master of the Rye Harbour Trust . . . . p. 101

The western and eastern groynes at Rye have been run out according to the opinion of the majority of those who happened to be sitting as Commissioners, 2006——Mr. Cubitt was consulted as to improvements, but the Commissioners did not concur in his Report, and would not act upon it, 1998——There are 48 Commissioners who attend tolerably well, 2010——There are three sluices across the three rivers about a mile above the town, which entirely stop the flow of the tide, 2024——If these were removed the tide would flow 10 miles up the Rother and 7 miles up the other rivers, 2025——The sluices were erected 50 years ago, and re-erected 10 years since, 2026——Scott's Float Sluice was broken down by the tide in 1813, and was down for two years; the effect upon the bed of the river was to deepen it, so that a boat could go up to the town at low water spring tides (*Stocks*), 2043——The indraught was so great that the flood stream continued to run up the river after the water had fallen two feet at the pier head, 2050——Dredging would be a great benefit to the channel, but cannot do it for want of funds, 2062——Average revenue about 1,300*l.*, last year only 1,050*l.*; amount of debt 1,500*l.*; expenses of management about 400*l.* a-year, leaving 600*l.* to be laid out in improvements, 2076——An area of 734 acres of marsh on the banks of the river, below the sluice, has been embanked since 1833, by consent of the Harbour Commissioners, 2087——In the event of a railroad crossing the river at a quarter of a mile above the town, it would prevent the passage of 112 sailing vessels annually that now go up to Scot's Float Sluice, 2125——Barges go 15 miles higher up the Rother to Bodiham Castle. At times great freshes in the Rother, 2106——Width of river at low water, at a quarter of a mile above the town, 102 feet; any bridge across would be an impediment to navigation. The eddy tides make the case more difficult; the tide rises 23 feet in the bay, and 14 feet at springs at the town, 2187——The Nook was embanked in 1839 without any authority, 2213——It excluded 10 million cubic feet of water on every spring. The Admiralty Commissioner did not report it to the Admiralty, because he thought the Nook without the jurisdiction of the harbour, 2224——Scot's Float Sluice was pulled down by the people, in 1830, as a nuisance, but was rebuilt by Act of Parliament, 2227——The Rye Harbour Commissioners were consenting parties to, and received 7,000*l.* for the 734 acres of marsh embanked in 1833. These lands were covered with 3 feet water at high tides, and thus 30 million of cubic feet of water were excluded, and its scour over the bar lost at every spring tide. All the Commissioners who consented to this arrangement were influential proprietors in the neighbourhood, 2246.

Millar, John, Engineer to the Glasgow Junction Railway Company . . . . p. 110
The proposed railway will cross the Clyde at a height of 39 feet above high water mark, with three arches, resting on two piers 15 feet wide each. The clear water-way of the river here is 430 feet; span of centre arch 180 feet. The objections to taking the line above Glasgow are—1st, The increased distance of six miles; 2ndly, That it would not be a thorough line, and so breaks up the traffic, as in witness's opinion, to be of no public benefit, 2276.

Holland, Edward, Commander R.N., residing at Truro . . . . p. 111
Is well acquainted with Falmouth Harbour. The changes he has noticed are new wharfs, and a large quantity of deposit brought down Restronguet Creek from the mines, whereby the shoal off Milor Point is increasing. The corporation of Penryn claim right over the harbour, as lessees of the Bishop of Exeter, 2286——Proposes to make a floating dock in Penryn Creek, a mile below the town. Vessels drawing 13 feet go up to Penryn at high water spring tides. Does not fear any deposit; backwater would keep the channel clear. At Hayle, a small port in St. Ives Bay, 7 feet depth has been gained by sluicing, so that vessels of 200 tons can go in, 2313——Nearly all the population of Penryn has petitioned the Admiralty in favour of the dock, 2320——Is of opinion that the upper part will not fill up. Rise of tide at Penryn 18 feet, 2328——Vessels lie in Carrick Roads at one and a half mile distance. Proposes to have 13 feet in dock, at low water springs, which is now dry, and to dredge the tidal basin and a channel outside. Locks will be placed between capable of admitting the largest steamers, 2356——Falmouth Harbour is efficiently lighted; no buoys are required, 2360.

Mackain, David, Secretary and Engineer to the Glasgow Waterworks Company . . . . p. 113
By Acts of 1825 and 1840 the Clyde Trustees are required to maintain the water at a certain level, 2363——The present weir at Stockwell Street Bridge is level with the original bed of the river in 1775. Since that time the channel of the river below has been lowered 9 feet. Spring tides rise 3 feet over the weir, and at that time punts can go up to Rutherglen. Was not aware that Rutherglen was formerly the port of the Clyde. A suit was commenced against the Clyde Trustees by the magistrates of Rutherglen in 1807, to oblige them to remove the weir; it lay in abeyance till 1834, was carried on till 1841, and settled by the present weir being constructed 500 yards higher up the river than the former one. Spring tides swell up to the Water-works two miles above the weir. There has been no navigation at Rutherglen, except for vessels that come through the bridges, since 1345. Immediately below the weir are 12 feet of water at spring tides, owing to dredging, and if the weir were removed, and the Clyde Trustees were so disposed, they might deepen all the way up to Rutherglen, provided they could otherwise secure to the Water-works and certain factories a supply of water at low tides, which they are bound to do by Act of Parliament, or to make compensation, 2402——Witness recommended in 1839 that a supply of water, either through a stone culvert or iron pipe, should be drawn from Carmyle, two miles and a half above Dalmarnock, and a Bill was brought into Parliament for that purpose; but the coal-owners and others objected, and it was lost. The expense of such a work would not exceed 50,000*l.* One objection to removing the weir would be that the hot water from some hundreds of steam-engines and the sewerage of the town would pass to and fro before Glasgow Green and vitiate the air, where the poorer people go to enjoy themselves on a holiday, 2410——In summer and in low states of the tide there is scarcely any perceptible current in the river; at that time the discharge of the Clyde does not exceed 100 cubic feet per second, 2411——Does not admit that if the weir were removed and the river deepened above, as below, a volume of 9 feet of water would sweep up and down every tide, and carry away all such refuse. At present the whole of the water that passes down past the Green at low states of the tide is pure, and the water below the town is extremely offensive, 2413——Since the Clyde has been deepened, the velocity of river in the heaviest floods has increased from four miles and a half to six miles an hour near the Water Works. In heavy land floods, even of eight feet elevation, the tide has no influence on the surface of the river. The valley of the Clyde is composed of such soft alluvial soil, and the river so tortuous, that if the weir were removed and the river deepened so as to cause the tide to increase the rise at the Water Works, the velocity of the current during heavy floods would be so great as to make the upper part of the river quit its bed, and much damage would ensue, 2415——Has not yet calculated the mean discharge of the Clyde, but has got seven years' observations ready to do so. In the lowest state of the river the quantity of water passing the Water Works does not exceed 100 cubic feet per second, while a flood 18

feet in height discharges about 35,000 cubic feet in the same time. The flood of February, 1831, rose 20 feet at the Cranston Hill Works, opposite Rutherglen. Is aware that Telford and Jardine gave it in evidence that if the bottom of the ford at Dalmarnock Bridge be secured, the weir may be taken away at Glasgow Bridge, and the Clyde deepened between those points for about 6 feet, without doing any injury to the Glasgow Water Works; but points out how their statement was qualified, 2417.

Fisher, John, Commander R.N., Principal Harbour Master of the Port of London . . . p. 117
Has been harbour master 26 years, 2419——The dry bank formed by old London Bridge has been removed and a depth of 11 feet water gained, 2420——Has lighters generally at work in the centre of the river in order to deepen it to 14 feet; the navigable channel has increased in depth slightly from the action of the steam-boats at low-water, 2421——After the shoal in Limehouse Reach the next considerable obstruction is Ham Shelf, which is a great nuisance to Her Majesty's ships that come up to Woolwich; on account of not having given the proper direction to the set of the tide all attempts to clear Woolwich Reach have hitherto failed; a deposit is also formed in front of the dockyard, to remedy which, Mr. Walker, in 1842, recommended that Hook Ness should be cut off, 2422——Fully concurs in Mr. Walker's recommendations in 1842 to the Port of London Committee; attended that survey with Captain Bullock, and approved of the lines for the sides of the river drawn by Mr. Walker, 2427——Is aware of irregularities in the bottom of the river above London Bridge, but his duties are strictly confined below bridge, 2428——Recommended the Navigation Committee to deepen the river from London Bridge downwards, but is not aware why this plan has not been carried out; it rests with the Committee; has pointed out the obstructions, and advised them to be removed, 2430——Formerly people took sand and gravel where they pleased from the river above bridge; in some places they had made holes of 1 foot, in others 5 or 6 feet; this was allowed, under the authority of the Lord Mayor, by the water bailiff, 2433——Excavations are now made under special directions of the water bailiff. Since 1842 there has been considerably more water in certain places, but they have not made a uniform depth in the channel, 2435——Those who are allowed to dig above bridge are directed by the water bailiff where they are to work, 2436——The only difficulties in widening the river would be the expense, and that it would affect many interests in water-side premises, 2443——Those at the side of the river should be called upon to pile and defend their property; jetties, barges, and craft are now run out from different private landing-places; during two-thirds of the tide these barges are aground, stop the free current of the tide, and cause a deposit. The Navigation Committee recommended the removal of all these nuisances, and objected to the manner in which licence has been irregularly given, 2446——No steps have been taken since that Report to prevent the accumulations which have taken place; some of the jetties have been removed, but the most objectionable still remain, 2447——One of these is at Greenwich, run out from Garden Stairs, 2448——To improve the river effectually all these jetties ought to be removed: is of opinion that others might be run out for the public benefit, under proper authority, and of open piles, 2450——No representation has been made by witness since the Report of 1842. Witness removed the pier at Greenwich that he complained of three times as a nuisance, but the Lord Mayor sent him an order to let it remain, 2452——The change of Mayors, &c., is very unfavourable to systematic work on the river; a committee of sailors, under one acknowledged authority, would soon carry out the requisite works. Since London Bridge has been removed the tides have risen higher and fallen out lower than before; in spring-tides it is occasionally 3 feet higher above the Trinity standard than it used to be. Hardly any mud is now found in the river, the steamers wash it all away. On the Whiting Shoal has raised 100 tons of soil a-day: the hard part, resembling plum-pudding stone, is blasted with gunpowder. Trinity dredgers raise 120 tons in 35 minutes, 2472——The clay under the gravel offers great impediments to dredging; expense is the only objection to clearing the river as recommended in the Report of 1842: the present irregular system is directly contrary to that Report: the Trinity Board will only take up material that is fit for ballast, 2503.

Six more vessels sunk within the last year lie between Northfleet Hope and Sea Reach; two near the edge of the Bligh Sand, where the Duc de Nemours grounded in 1843. No immediate measures are taken to remove vessels, some lie 18 months, 2515——The Barking Shelf delayed the Royal Yacht for two hours on her passage to Woolwich; it is of clay, peat, and gravel. Cold Harbour Point, the shoal in Erith Reach, Dagenham Shelf, Bugby's Hole, and the Middle Grounds between Blackwall and Greenwich still remain as in 1842. With the machinery at present in use there would be no difficulty in making the Thames of one uniform depth as recommended in the Report of 1842. The mud still fills up in front of Woolwich dockyard. Agrees with Mr. Walker that the only remedy is to cut off Hook Ness. Either shingle for ballast, or mud dredged up might easily be deposited on the Isle of Dogs or elsewhere. In Woolwich Reach steamers are obliged to wait two hours at times to pass Ham Shelf. If sufficient depth of water, by judicious dredging were maintained on the face of the quays both at Greenwich and elsewhere, there would be no necessity for projecting piers of any sort, 2579.

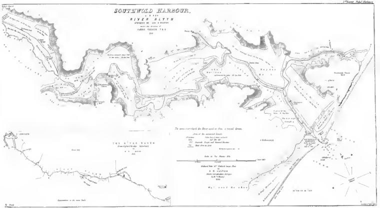
Cubitt, William, Vice President of Inst. of Civil Engineers . . . . p. 124
Enumerates the different harbours and rivers he has examined professionally and reported upon. Knows of no general rule for improvement applicable to rivers. Crookedness of channel and unevenness of depth are the chief obstructions to the propagation of the tide. Depth in rivers is chiefly due to tides as far up as neap tides reach, above that point to freshes. More to be feared for our harbours from silt brought in from the sea than from detritus brought down by freshes. Has improved the Severn upon two principles; first, as a tidal river by embanking and deepening; secondly, above the influence of the tide by making the river into a series of levels or ponds connected by locks and weirs. By means of four weirs a constant and uniform depth of six feet has been obtained for 20 miles where formerly were only 18 inches, and navigation entirely at a stop; and the same improved depth is nearly completed for 30 miles in the tideway above Gloucester, 2596——If witness were instructed to improve the navigation of the Severn for seagoing vessels he would make a ship canal across the isthmus at Hock Crib with double stop locks at both ends of the cut, leaving the river to go round by Newnham as at present; would also embank many thousand acres of the Nooze Sands just below. If the tide were stopped altogether at Hock Crib it might be better for all the lands above and the navigation below. There are difficulties in controlling the tide; it would be easier to stop it, and pass

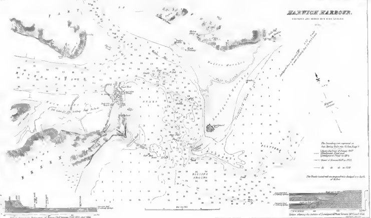
the flood water over a weir, 2602——A depth of 15 to 20 feet of quiet water to Gloucester would be much better than having a roaring furious bore all the way. A weir of 3 inches thick would carry off the heaviest floods, and a perfect navigation might be completed to Stourport, from 60 to 70 miles, 2604——The only way to improve Rye Harbour would be to get a good channel out to low-water mark, a distance of 1½ mile; a breakwater or pier is now being carried out there under witness's advice. Scot's Float Sluice has been lately rebuilt under his direction. The tide formerly went up the Rother 15 miles; it was a sluggish stream, a portion was inned out, and by degrees as the land rose more was inned out till they reached the sluice. Before taking the sluice down the embankment must be raised more than three feet. The Rother would silt up, in witness's opinion, if the sluice were taken down. There is no back water, no length of stream to keep it open, nor can any be obtained by deepening the channel, 2618——Has no doubt but that Rye Harbour was formerly deeper; but does not now think it worth the expense that would be requisite to keep it deep. Land covered at neap tides should not be embanked. Would recommend dredging Rye Harbour up to Scot's Float Sluice, regulating and straightening the channel, and carrying down the eastern work to low-water mark in a straight line. Is of opinion that 18 feet at high-water springs may be maintained at Rye, 2665——The proposed railway could not well pass above Scot's Float Sluice without much tunnelling, as alongside the river is a steep cliff; sees no objection to allowing it to cross by a swing bridge, properly constructed at a quarter of a mile above the harbour; the impediments to navigation would be but slight. Is of opinion that many harbours in the kingdom are much improved by engineering. Considers that Government have more power to do evil than do good. A central Government Board, with adequate authority, of the highest possible character, and with sufficient funds at its disposal, if properly administered and without jobbing would certainly be of great benefit to our harbours. It should be a permanent Board of the highest standing, 2651.

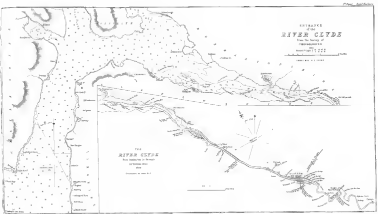
Russell, John Scott, Civil Engineer, resident in London . . . . p. 130
Has examined and reported upon the rivers Dee, Mersey, Clyde, Tay, and others; has made experiments specially with a view to determine the cause of the retardation of the tidal wave, whence it appears that the acceleration of the wave is not due to a large area of water-way, but chiefly to the mean depth of the channel. The tidal wave is propagated according to the same law as a wave of the first order; that is, its velocity is proportioned to the square root of its depth. The result of 10 years' experiments gives that, in 10 feet depth of water, the velocity of the tidal wave would be 12 m. an hour, 20 feet depth 16 m. an hour, 30 feet depth 20 m. an hour, 50 feet depth 26 m. an hour, 70 feet depth 32 m. an hour, 100 feet 34 m. an hour. The same experiments in a channel of the same depth, but shelving gradually to the bottom, reduced the velocity to one-half; the best form for a channel, therefore, is to be as rectangular as possible, consistently with other circumstances. Shallows in a river immediately reduce the velocity of the tidal wave to the rate due to a similar depth of water throughout the channel, whatever velocity it may have in deep water above or below the shoals, 2692——By means of the table contained in the "Report on Waves" in 1844, could, by knowing the velocity of the tidal wave, predict approximatively the depth of water in the channel of the river. A shallow in a river retards the time of the commencement of the flood much more than it does the time of high water. The chief effect of lateral projections is to interfere with the flow of the tidal wave so as to diminish very much the quantity of water that enters without materially affecting the time of its progress. The most notorious case of interruption is in the Dee, where the Dee Company, for the purpose of reclaiming land, have diverted the course of the river. Considers this a case calling for the immediate interference of some controlling power. In 1836 a proprietor run out a small projection from the south bank, which turned the course of the stream nearly at right angles, so as to ruin all the small creeks immediately below it, 2700——The obstruction still exists, and the effect has been a tortuous undefined channel for a distance of 5 miles above Flint Castle. Has no doubt that Chester might be restored to its former eminence as a port, 2709——During the early part of last century, large vessels could go up and ride under the walls of the port; now a vessel of 8 feet draft can only go up at high water spring tides. A very material improvement might be made for 50,000*l.* The entire ruin of the estuary has been caused by the injudicious reclaiming of land to an enormous extent by a Company formed in 1750, under Act of Parliament, 2715——At Flint, the tide rises 33 feet; at Chester, 9½ feet. No doubt that 22 feet water might be obtained to Chester. Chester Bar lies 5 miles from the Point of Ayr, and has 12 feet over it at low water springs. From Ayr Point upwards, where it is now nearly dry, large ships could formerly ride; attributed solely to the injudicious embankments just alluded to, 2731——Had it been done with judgment, land might have been reclaimed, and the navigation unimpaired, 2734.

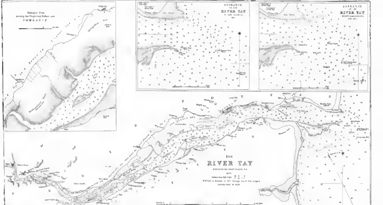
English, William, Millwright, and Contractor for Dredging . . . . p. 138
Has been engaged dredging parts of the Thames, and is now at work on the Whiting Shoal, a sort of concrete or plum-pudding stone in Limehouse Reach. Cost of dredging it is 1*s.* a cubic yard; gravel is lifted at 5*d.* per cubic yard, of 26 cwt.; lighterage is a separate charge, varying from 9*d.* to 1*s.* Is not allowed to raise gravel below London Bridge, it is monopolized by the Trinity House for ballast, 2825——No directions given by the water bailiff or other person to deepen a channel in the river, only not to go within 100 feet of the shore on each side. There would be no difficulty, but the expense, in deepening a uniform channel of the river to 6 feet at low water, from London Bridge to Gravesend, 2839——His two engines, of 10-horse power each only, can take up 600 tons daily in 10 hours. Supposing the quantity of soil to be removed from the Thames to be 1¼ million of cubic yards, it could be done in four years, with two engines of 24-horse power each. The Whiting Shoal is about half a mile long; witness is cutting a channel through it of 50 yards in width; the soil is composed of gravel, about 6 inches, then clay, 2 feet; then a substance between a clay and stone, and then stone. Permitted to deepen above bridge 10 feet below low-water mark, except when near a bridge; formerly has dredged to 27 feet in some parts. No difficulty, if required, in dredging the Thames, from London Bridge up to Wandsworth, or from London Bridge downwards to Gravesend, 2880.

LONDON: Printed by WILLIAM CLOWES & SONS, Stamford Street,
For Her Majesty's Stationery Office.


SOUTHWOLD HARBOUR,
RIVER BLYTH
under the direction of
JAMES WALKER F.R.S.
The space over which the River used to flow is tinted Green.
Walberswick
SOUTHWOLD HARBOUR
Southwold Church
S. E. SALTER


HARWICH HARBOUR.
ESSEX
The Soundings are expressed in Feet, Spring Tides rise 12 Feet, Neaps 7
Shore line of Beacon Cliff Landguard Point 1804
Do do do in 1808
Section shewing the Increase of Landguard Point between 1804 and 1846
Section shewing the Destruction of Beacon Cliff between 1709, 1804 and 1846
PLATTERS
ROLLING GROUND
STONE
Landguard Fort
Harwich
Walton Marshes
Beacon Cliff
Magnetic Variation


ENTRANCE
of the
RIVER CLYDE
From the Survey of
DUMBARTONSHIRE
RENFREWSHIRE
THE
RIVER CLYDE
From Dumbarton to Glasgow
GLASGOW


Enlarged Plan
shewing the Projecting Dykes near
POWGAVIE
ENTRANCE
OF THE
RIVER TAY
ENTRANCE
OF THE
RIVER TAY
THE
RIVER TAY
1833

RYE HARBOUR.

SURVEYED BY MESSRS SHEPPARD & HALL
under the direction of
Wm CUBITT F.R.S. M.R.I.A. & CIVIL ENGINEER
1840
the Entrance of the Harbour from an eye sketch in
1845.